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THE PATHOLOGY OF CERTAIN VIRUS DISEASES¹

THE term "virus diseases," as used in this title, has reference to that group of acute infectious diseases whose etiological agents have not yet been cultivated with certainty on artificial media but have the common property of filterability through earthenware or porcelain filters.

Notwithstanding the fact that a very great number of infectious agents, both bacterial and protozoan, have been demonstrated and cultivated during the past fifty years, there remains a surprisingly large residuum of infections which may be included under the term "virus diseases."

There is a very wide distribution of the virus infections both within the animal and plant kingdoms. For example, among the diseases of man belonging to this group are such important examples as smallpox, poliomyelitis and rabies. The group may be represented among the lower animals by such instances as foot and mouth disease, rinderpest and hog cholera. In plants there is the mosaic disease of tobacco and numerous others. It is probable also that the bacteriophage of D'Herelle belongs in the same category. The biological importance of the filterable viruses may be further illustrated by the fact that certain tumor-like diseases are known to be caused by these agents, namely, Rous's chicken sarcoma and fowl leukemia.

It is of particular interest from the standpoint of pathological and cytological studies that the lesions of many virus diseases are associated with specific cellular inclusions, the nature of which has not as yet been determined with certainty. The inclusions may be situated either within the cytoplasm of the cells involved, within the nucleus or within both. As examples of intra-cytoplasmic inclusions may be mentioned those of rabies, smallpox, vaccinia, trachoma and molluscum contagiosum of man. In the fowl characteristic inclusions occur in epithelioma contagiosum. Inclusions confined within the nucleus have been demonstrated in herpes simplex, herpes zoster and varicella in man, and in the nuclei of cells of the central nervous system in the encephalitis of horses, known as Borna's disease.

These inclusions from time to time have been considered to be protozoan parasites, or the products of

¹ Read before Section N (Medical Sciences) American Association for the Advancement of Science, Nashville, Tennessee, December 28, 1927.

cellular degeneration or reaction products incorporating the virus. The last hypothesis was formulated several years ago by von Prowazek; and he designated the viruses inciting the specific cellular reactions Chlamydozoa. Lipschutz, a little later, included under the term Strongyloplasms the minute, uniform, granular components of inclusions which could be demonstrated in fresh preparations and in smears. He regarded these minute bodies as the visible form of the infectious agent. In this group he included the viruses of fowl-pox, molluscum contagiosum of man, sheep-pox, variola and vaccinia. These minute structures were demonstrated in smears from the lesions of fowl-pox and sheep-pox first by Borrel in 1904, in smears of molluscum contagiosum by Lipschutz in 1906, and about the same time in the lesions of variola and vaccinia by Paschen.

In the present study which I will report, our interest has been directed toward an investigation of the nature of the inclusions, particularly in the lesions of fowl-pox and molluscum contagiosum.

Fowl-pox is a contagious, eruptive disease which occurs often in epidemic form in chickens, pigeons, turkeys, geese, pheasants and other species of fowl. The lesions consist of a nodular exanthem which appears particularly on the unfeathered parts of the body, especially about the head. They represent essentially an epithelial hyperplasia. Only surfaces lined by squamous epithelium are affected, the lesions being strictly confined to the epidermis and to the mucosa of the mouth, nasal pharynx, the esophagus, crop and occasionally the cloaca. During the eruptive stage of the disease the virus is present in the blood and probably in all the organs of the body, although there are no demonstrable lesions in the internal organs. Within the eruptive lesions the virus is present in a very high concentration, and the disease may be induced by inoculating a susceptible fowl at any point on the skin, where epithelial cells have been injured by scarification or by plucking feathers. In early stages of the disease, while the virus is circulating in the blood, local lesions may be induced by simple scarification or the removal of feathers at any point. Notwithstanding its wide dissemination in the body it appears that this virus proliferates for the most part, if not entirely, within the eruptive lesions.

On microscopic examination the nodular lesions are found to be due essentially to an epithelial hyperplasia. Practically every epithelial cell of the lesion contains within its cytoplasm a large, discrete, compact body which possesses an eosinophilic staining reaction and has a hyalin appearance. These inclusions are larger and more numerous as the surface is approached. They may be absent in the cells of the Malpighian layer. It has been demonstrated that

their formation begins near the basal layer by the condensation of an apparently amorphous material about one or more intracytoplasmic globules, or as they appear in fixed preparations, clear vacuoles. This material increases in abundance until it entirely covers or replaces the vacuole. Cells containing these inclusions are larger than normal, the mitochondria are intact, the nucleus shows no evidence of disintegration, and there is no indication that the cell thus altered is degenerating. Not infrequently one may find particles within the cytoplasm which appear to have been extruded from the nucleus. These particles do not take part in the formation of the specific inclusions. From a study of the cells in which the inclusions are developing we are convinced that the latter are not derived from preexisting material within the cell through degeneration nor through the formation of any constituent which the cell may produce during its differentiation. On the contrary, the inclusion appears to be constituted of a new and foreign material which accumulates in abundance within a vitally active cell.

In fresh preparations it is easily possible to tease out from fragments of a nodule numerous inclusion bodies, so that they are free from the cell. Such liberated bodies suspended in physiologic saline solution have the appearance of round, elliptical or lobulated, refractive, homogeneous, hyaline masses which are plastic and can be pressed or squeezed easily into various forms. When these masses are suspended in distilled water they swell rapidly, increasing greatly in size within a period of one half to one hour. As they imbibe water they assume a grossly granular appearance, later becoming transformed into a mulberry-like mass of globules suspended within a hyalin matrix. When the globules have reached a considerable size it can be seen by ordinary illumination under high magnification that they contain innumerable minute particles exhibiting an extremely rapid molecular motion. Sometimes the rapidly moving particles will stick to the periphery of a globule so that they may be photographed. The inclusions do not swell to the point of rupture, but remain definitely circumscribed. By compression, however, the minute bodies may be liberated and can be seen with ordinary illumination or in a dark-field preparation, as minute, spherical bodies having a diameter of about .25 micron. If physiological saline be added to the distilled water preparation the unruptured bodies will rapidly contract through the loss of water, becoming hyaline, wrinkled and apparently homogeneous.

By compressing an inclusion and staining it by a suitable method in a dry preparation it can be seen that it is composed essentially of two constituents; the one consisting of great numbers of minute,

spherical bodies uniform in size and staining reaction, the other a homogeneous, faintly staining, amorphous material in which the minute bodies are suspended. The staining method which we have devised for this purpose is as follows:

A smear preparation dried over a flame is mordanted one minute with a .25 per cent. aqueous solution of potassium permanganate. It is then rinsed in running water and stained one minute with a few drops of the following solution: Alcohol (30 per cent.), 100 cc.; basic fuchsin, 1 gram; phenol (crystals), 1 cc.; anilin oil, 1 cc.

The stain is washed off in running water, and the preparation, blotted and dried, is ready for examination. This method of staining is not attended by the formation of any precipitate and stains the minute bodies quite sharply.

Thus from a morphological standpoint it is possible to demonstrate that the specific inclusions of fowl-pox are formed within the cells by the accumulation of a foreign material within the cytoplasm unattended by evidences of degeneration, and that these specific inclusions are constituted of minute, uniform bodies in great numbers, suspended and surrounded by a hyaline matrix. Morphologically, therefore, it is possible to demonstrate structures which resemble a minute micro-organism as the important constituent of the inclusion. These minute structures are in numbers sufficient to account for an infectiousness of material from the lesion in high dilutions. The minute bodies are small enough apparently to pass through the pores of a Berkefeld filter. It would appear from the fact that minute bodies are surrounded by a homogeneous matrix that filtration experiments might be attended with difficulties, and this experimentally is found to be the case. The incorporation of the minute structures within a hyaline matrix, which seems to be of a semipermeable nature, and appears to have a lipid and proteid structure, might protect an enclosed micro-organism against such physical changes as dehydration by drying or glycerination.

We have demonstrated that the minute bodies are preserved in dried or glycerinated preparations after periods of many months (six) by soaking such material for twenty-four hours in distilled water, making smears and staining as above indicated. This material was infectious.

It has further been possible to show, we believe, that active virus is associated with the inclusions. By bacterial putrefaction it has been possible to soften and disintegrate the epithelial cells of lesions, leaving the inclusions apparently intact. By repeated washings and centrifuging at low speed the inclusions

have been freed in large part from adherent cellular material and bacteria. A suspension of these inclusions was centrifuged at high speed. The supernatant fluid inoculated upon the skin of a susceptible fowl proved to be non-infectious, while the sediment, consisting of inclusions, proved to be highly infectious when similarly inoculated upon the skin.

From these observations we are convinced that in fowl-pox we have to do with a specific infectious disease due to a living microorganism which is visible under the microscope. This microorganism, we believe, invades the epithelial cells of the lesion; and the daughter cells, resulting from the division of an infected cell, will carry the virus by direct transmission. The microorganism proliferates within the cytoplasm of infected cells resulting in the formation of minute colonies suspended in a hyaline lipo-protein material which constitutes the specific inclusion.

The epithelial inclusions of molluscum contagiosum of man are composed essentially of the same type of minute bodies which can be demonstrated in suitably stained smear preparations and in fresh preparations with ordinary illumination. In fresh preparations the minute bodies can be seen in rapid molecular motion in every way similar to that exhibited by the bodies within the globules of swollen fowl-pox inclusions. In molluscum, however, there is not so dense a matrix; consequently, the inclusions are more diffuse and, because of their corpuscular content, appear finely granular in stained sections of the lesion. In molluscum contagiosum it is believed that we have to do with an acute infectious disease similar to fowl-pox, and caused by a visible microorganism which penetrates and proliferates within the affected cells of the lesion. This conception has been advanced by Lipschutz and by da Rocha-Lima.

Through the studies of Borrel, Paschen and others it seems possible that a similar microorganism may be the etiological factor in the diseases sheep-pox, variola and vaccinia.

This group of virus diseases then offers, we believe, a particularly favorable material for further etiological investigations.

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ANALOGIES BETWEEN PHYSIOLOGICAL RHYTHMS AND THE RHYTHMICAL REACTIONS IN INORGANIC SYSTEMS

THE periodic or rhythmical reactions of inorganic chemistry are surface reactions, characteristic of poly-

phasic systems of a somewhat special type.¹ Typically they occur at the boundary between certain metals (iron, chromium, nickel and others) and electrolyte solutions, usually acids, and are always associated with variations in the electrical potential of the metallic surface. In some cases the metal shows a spontaneous rhythmical reaction with the solution (*e.g.*, iron in nitric acid, mercury in hydrogen peroxide); in others the rhythm occurs only during electrolysis, usually with the metal as anode (*e.g.*, periodic sulphide or iodide electrode reactions). A constant feature of each single reaction in the rhythmical sequence is the formation of an insoluble reaction-product which is strongly adsorbed by the metallic surface, forming over the latter a thin impermeable coating or film. This film limits or prevents the reaction between the phases and at the same time alters the interfacial potential; the reaction then ceases (or its velocity is greatly reduced) until it is renewed by some secondary reaction which removes or alters the film. In the spontaneous rhythms, *e.g.*, of iron or mercury just cited, the removal or dissolution of the film occurs rapidly as the result of a local electrochemical reaction which is propagated over the whole surface; the film is then reformed and the cycle is repeated. Under uniform conditions the succession of reactions exhibits a rhythm of remarkable regularity. From the standpoint of the physiological comparison it is of special interest to note that the formation of interfacial films and their dissolution under a transmitted electrochemical influence are the essential factors governing the peculiar behavior of such systems.

The parallels with the rhythmical reactions of living tissues (of the heart, nerve centers, cilia) have long attracted attention; and some years ago Bredig and his students,² in a series of studies on the rhythmical catalysis of hydrogen peroxide by mercury, pointed out various features of special physiological interest, such as the synchronism between the rhythms of reaction velocity and electromotor change, the dependence of the rhythm on the alternate formation and dissolution of an interfacial film, the high temperature coefficient, the sensitivity of the rhythm to H-ion concentration and the presence of foreign substances, and the part played by local circuits in electrolyzing and removing the film. Such striking resemblances point to some fundamental identity in the general conditions controlling the reaction velocities in both types of system.

¹ A comprehensive account of these reactions is given in the monograph by R. Kremann, "Die periodischen Erscheinungen in der Chemie," Ahrens Sammlung chemischer und chemisch-technischer Vorträge, 1913, Bd. 19, p. 289.

² Cf. Bredig and Wilke: *Biochem. Zeitschr.*, 1908, Vol. 11, p. 67; Antropoff: *Zeitschr. f. physik. Chem.*, 1907, Vol. 62, p. 513.

The rhythmical reaction of pure iron wire in HNO_3 exhibits under certain conditions even more detailed analogies with the physiological rhythms. The tendency of iron to react rhythmically with nitric acid and the similar behavior of iron anodes in sulphuric acid have long been known; the precise conditions of the rhythm have, however, not been clearly analyzed; in particular its relation to the varying properties of the surface-film has been insufficiently considered. This relation is important because the whole resemblance to the physiological rhythm depends on the control of the reaction cycle by periodic variations in this film. It is now widely recognized that variations in the semipermeable protoplasmic membranes or surface-films underlie the response of irritable tissues to stimulation. The primary reactions in stimulation are surface reactions, as is shown clearly by their sensitivity to changes of electrical polarization and to the presence of surface-active compounds. The bioelectric variations of stimulation are also evidence of the part played by surface processes; these variations are now very generally referred to changes in the polarization of the protoplasmic membranes (membrane theories), and there is independent evidence of parallel variations in permeability. The well-known dependence of electrical stimulation on the polarizing action of the current (shown by Nernst and others), and such general physiological facts as chronaxie, polar stimulation and inhibition, together with the temporary existence of a non-reactive or refractory period following excitation, are other features of agreement between the living system and the inorganic model.

The rhythmical reaction of iron in nitric acid consists essentially in an alternation of active and passive periods, the latter corresponding to the film-covered condition. Not all specimens of iron show a regular rhythm in nitric acid; an irregular or local rhythm is common, but a rhythm in which all parts of an extensive surface—*e.g.*, of a long wire—are simultaneously active is found only in iron having special properties, the chief of which are a rapid and complete transmission of the active state over the whole surface when the metal is locally activated (as by scratching or touching with zinc) and a rapid return of transmissivity after activation. Such properties are shown most completely in soft iron of low carbon content; pure iron wire prepared by electrolysis³ and the pure commercial wire known as Armco⁴ exhibit an especially beautiful and regular rhythm under the conditions described below. In hard steel wire (piano

³ Kindly supplied by the U. S. Bureau of Standards, Washington.

⁴ American Rolling Mill Co. The carbon content is *ca.* 0.1 per cent., according to analyses furnished by the Company.

wire), on the other hand, the tendency to rhythm is almost entirely absent. In this case the non-transmissive period ("refractory period") following activation lasts for several minutes (in 70 v. per cent. HNO_3 at 20°), indicating the presence of a relatively thick or resistant passivating film; while in Armco wire under the same conditions complete transmission is again possible within less than one second after the passage of an activation wave. The remarkable rhythmic properties shown by this wire are closely connected with its power of rapid recovery, the rate of rhythm being directly determined by the duration of the brief non-transmissive period following each activation. Armco wire was used in the following experiments.

When short pieces of iron wire (1 to 2 mm thick, 1 to several cm long), previously passivated, are placed in a flat-bottomed vessel containing nitric acid of 60 to 75 v. per cent. concentration⁵ and activated by a single brief contact with zinc, usually a rhythmic reaction begins at once. At regular intervals (of one half to one second) the dark effervescent surface of the metal becomes momentarily bright and inactive, indicating the passive state; in 70 v. per cent. HNO_3 the passive period is brief as compared with the active period; as the strength of acid is increased up to 80 per cent. its relative duration becomes longer.^{5a} If the acid is well stirred during the reaction the rhythm continues uniformly until the metal is largely dissolved away; if stirring is omitted the reaction soon becomes irregular and passes into a continuous effervescence.

Further study of this phenomenon soon showed that the essential condition determining the persistent rhythm is the presence of some local area or areas in which the reaction of the metal with the acid is continuous. From such an area waves of activation travel at intervals over the whole wire. Such an active region is formed wherever a sufficient surface of the metal is in contact with the glass or is otherwise protected against free renewal of the acid; the latter is there depleted by the reaction and soon becomes too weak to repassivate the iron. When the wire is suspended freely in the acid (by thin glass threads) no rhythm is shown; a touch with zinc then elicits a single reaction which is transmitted rapidly

over the whole wire; the latter then immediately becomes again passive and remains so until again activated. The interval between such successive activations may be less than one second; at every touch the wire gives a single reaction and reverts automatically to the passive state. Such experiments illustrate the brevity of the period of recovery in this wire; they also show that the passive state is the state of equilibrium in acid of more than a certain critical concentration. In acid of less than this concentration (ca. 55 v. per cent.) automatic repassivation does not occur; the wire when activated continues to react until it is completely dissolved. This is the condition in the local protected area of the rhythmical wire. Such a continually active region may be compared with the nodal or pace-making region of the heart, or with the basal body (or "blepharoplast") of a cilium; it exerts a constant activating influence to which the external passive part of the wire responds as soon as it is sufficiently recovered. The rate of the rhythm is thus dependent on the duration of the temporary non-transmissive period, which is comparable with the refractory period of the living irritable tissue.

The chief conditions for the maintenance of a regular rhythm may be defined as follows: (1) acid of uniform concentration sufficient to reform the passivating film promptly after each activation (60 to 80 v. per cent.); (2) rapid recovery of transmissivity by the wire; and (3) presence of a local continuously reacting region sufficiently large and active to exert a constant activating influence⁶ on the adjoining passive regions. These conditions were satisfactorily met by the following simple arrangement. The wire was supported horizontally, about 0.5 cm from the bottom, in a crystallization dish 10 cm wide, furnished with an outflow tube inserted into its side ca. 1.5 cm above the bottom. The support was furnished in some experiments by two thin glass threads suspended between the two limbs of a U-shaped glass rod lying on the bottom; in other experiments a bent wire was used, one end of which was attached to a key for making electrical connections; in this case a straight length of wire, 4 to 6 cm long, was exposed to the acid, while the bend (where the wire passed into the air) was coated with paraffin to prevent irregular action. Acid was led into the dish by a siphon connected with a large supply bottle; the slow flow of acid provided the necessary stirring.

⁶ *I.e.*, An influence similar to that which the continual contact of zinc would have. In fact, contact with zinc will maintain a rhythm in an iron wire suspended in 70 per cent. HNO_3 , but it is impossible to keep the conditions constant in such an experiment and the rhythm is irregular.

⁵ Volumes of HNO_3 (C. P., sp. gr. 1.42) in 100 volumes of solution.

^{5a} This variation in the relative durations of active and passive periods is clearly shown in photographic records of the electromotor variation, taken with the string galvanometer. The current was led to the string from the sliding contact and terminal of a low resistance tube rheostat connected with the pulsating wire and an indifferent platinum electrode immersed in the acid.

Opposite the free end of the wire was placed a short glass tube of caliber slightly wider than the wire. When the wire is inserted into this tube for a short distance (2 to 4 mm) and activated by touching with zinc a continuous reaction is readily started in the enclosed region, which is protected from free renewal of acid. The area of this active region can be adjusted by inserting the wire more or less deeply into the tube. From this region waves of activation pass in regular succession over the whole wire. The rhythm shown under these conditions is remarkably regular and continues indefinitely, *i.e.*, until the enclosed end of the wire is dissolved away. At any time the reaction may be brought to a stop by removing the tube from the wire; the latter then immediately becomes passive.

Since complete transmission and rapid recovery are necessary conditions for the rhythm, their general conditions should first be considered. The transmission itself, as is well known, is an effect of the local circuit formed between the active and the passive areas, the latter being cathodal; the film is there broken down by electrolytic reduction and the process of disruption spreads automatically, since it is repeated wherever anodal and cathodal areas adjoin each other. The process may be regarded as in the nature of a two-dimensional explosion, *i.e.*, an explosive reaction confined to the thin layer (probably monomolecular) of reactive material at the phase boundary. According to the usual conception of explosions, a reaction becomes explosive when heat is produced locally more rapidly than it is conveyed away. The film-conditioned type of chemical transmission differs, however, from the three-dimensional explosion in that the essential factor determining the spread of reaction is not a certain critical local heat-production, but a certain critical intensity of electric current between the reacting area of the surface and the passive region adjoining. If the current intensity (or density) is insufficient, the reaction fails to spread; in other words, a certain threshold must be overpassed. When the current intensity exceeds the critical level required, there is an automatic spread of the reaction to an indefinite distance, *i.e.*, over the entire area of the film—assuming the latter to have uniform properties throughout.

In another respect this type of explosive process differs from that in three-dimensional masses of material, such as explosive gas mixtures or compounds: *i.e.*, materials are at hand, in the direction of the third dimension, for replacing the film, so that a second reaction may become immediately possible. A certain interval is required, but this may be brief; in pure iron wires in 70 v. per cent. HNO_3 it is about one half second at 20°; in living systems, such as nerve,

it may be much less; the system can then react as before. The interval represents a temporary non-transmissive or "refractory" period, during which the reactive molecules are to be regarded as assembling at the surface, and presumably there undergoing orientation or other change favorable to reaction. The refractory period thus corresponds to the interval required for the formation of an adsorption film having definite characteristics. In general it should be noted that such surface reactions, since they depend on the conditions present in thin layers—where distances are small and the time required for access of material from either adjoining phase is correspondingly brief—are subject to rapid fluctuations of velocity. The quick initiations and arrests shown in the stimulation processes of living organisms—as well as their electrically conditioned character—are in themselves evidence that the controlling chemical reactions are surface reactions. Similar considerations apply to the physiological rhythms, which represent automatic and regularly repeated stimulations.

CONDITIONS DETERMINING THE RATE OF RHYTHM

Extent of pace-making area: In general any increase in the area of the continuously active or controlling region is found to accelerate the rhythm, while any decrease retards it. The rate can thus be regulated by inserting the wire for a greater or less distance inside the tube. If the active region be decreased beyond a certain length (of 1 or 2 mm) it becomes suddenly passive, by spread of the external passive area, and the rhythm ceases. There is thus for each concentration of acid a certain minimal area of the controlling region, corresponding to the slowest rhythm which is stable under the conditions. The rhythm can readily be doubled by inserting the wire for 4 to 5 mm into the tube; this increases the anodal area of the local circuit, and hence also the intensity and reducing effectiveness of the current at the adjoining passive area. A dependence of the rhythm in the rate of the local cathodal reduction is thus shown. This effect is readily understood when we consider that the film at its first deposition is refractory to reduction and attains its final state of maximum reactivity by a progressive process.⁷ Hence at a given interval a stronger local current may cause activation while a weaker one is ineffective.

Concentration of Acid: Within the range of concentration in which a regular rhythm is shown (60 to 80 v. per cent.) the rate increases with concentration, in a manner approximately linear. With the controlling region kept at its minimal area, as above de-

⁷ Following a curve of the type $R_t = R_0(1 - e^{-kt})$, as indicated by my earlier results on steel wires (*Journ. Gen. Physiol.*, 1925, vol. 7, p. 493).

scribed, the following rhythms were found characteristic (at 22-23°).

Concentration (v. per cent. HNO ₃)	Rate per minute
60	34-36
65	50-56
70	62-70
75	80-90
80	> 100 (becomes irregular)

In 80 v. per cent. acid a regular reaction is difficult to maintain, probably because of too great heat-production at the site of the controlling reaction.

Temperature: The temperature of the acid was controlled by a water bath surrounding the supply bottle. The following rates are typical for 65 v. per cent. acid at temperatures between 10° and 30°. Below 10° the rhythm is uncertain and above 30° it tends to accelerate and become irregular. As before, the wire was adjusted to give the slowest rhythm that was stable under the conditions.

Temperature	Rate per minute
10°	14-16
15°	28-32
20°	46-50
25°	84-88
30°	122-128

The range of temperature within which the rhythm is stable is not large and is similar to the physiological range, although the precise significance of this correspondence is not clear. It may be that the film is not sufficiently stable at higher temperatures, while at lower temperatures the reaction is too slow for effective reduction.

The correspondence of the temperature coefficient with that of the physiological rhythms is striking; the Q_{10} value is $2\frac{1}{2}$ to 3, equivalent to a value of 17,000 to 22,000 for μ in Arrhenius' exponential

formula, $\frac{k_2}{k_1} = e^{\frac{\mu}{2} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)}$ where k_1 and k_2 are the

velocity constants at the absolute temperatures T_1 and T_2 . As already pointed out, the interval between successive reactions represents the time required for the surface-film to attain a certain degree of reactivity, i.e., of reducibility by the local active-passive current. In the case of steel wires the rate of change in the film at different temperatures has been determined, using the recovery of transmissivity as criterion; the temperature coefficient of this recovery process is the same as that of the rhythm.⁸ This correspondence is further evidence that the chemical change in the film determining the recovery of transmissivity is also the condition determining the rate of

⁸ *Journ. Gen. Physiol.*, loc. cit., p. 500.

rhythm. This is apparently also the case in the cardiac rhythm, where the temperature coefficients of refractory period and of rhythm are closely similar or identical.

Other factors influencing the rhythm: As in the case of the heart beat, the rhythm of passive iron is affected by electrical polarization. When the pulsating wire is connected through a rheostat to an external source of current, making the wire anode has a retarding or inhibiting effect, while making it cathode causes acceleration. These effects vary characteristically with the intensity of the polarizing current; sufficient anodal polarization stops the reaction, while sufficient cathodal polarization renders it continuous. Polar effects of an analogous kind are well known in living tissues. A more detailed description of these and other parallels will be given elsewhere.

There is also a remarkable relation between the rate of rhythm in a pulsating wire and the total length of the wire, the rate decreasing at first rapidly, then slowly, with increase in the length. The following rates were found characteristic for different lengths of regularly pulsating wires, at one end of which a pace-making region was established by encircling the wire by a glass ring 3 mm long. The same ring was used in all experiments; the concentration of acid was 70 v. per cent. and the temperature 20°-21°.

Length of wire (cm)	Rate per minute
30 and 18	40-46
12	42-46
8	46-50
6	48-54
4	60-64
3.5	64-68
3	66-72
2.5	68-74
2.0	82-92
1.5	84-96
1.0	100-108
0.75	> 120 (less regular)

This phenomenon appears to be an expression of the mutual influence which the active and passive areas of the same wire exert upon one another.⁹ The presence of a passive region has a restraining or inhibiting effect upon activation in other regions of the wire; reactivation at the region adjoining the pace-making area is thus delayed until the activation wave has extended over the whole length of the wire. There are biological analogies here also; in general it is observed that the frequency of ciliary beats or heart beats decreases as the linear dimensions of the tissue increase. In such cases it seems clear that a dis-

⁹ This influence was early noted by Schönbein, *Philos. Mag.*, 1836, Vol. 9.

tance action, possibly of the same kind as that observed in the experiment just described, plays a controlling part in the determination of rhythm: i.e., the latter depends on a coordinating influence, in the general nature of a removal of restraint, transmitted at a finite velocity from the pace-making region. Correspondingly, we find that when transmission is locally impaired in the heart, fibrillation often occurs, at a rhythm typically faster than the main rhythm. In such cases local pace-making regions are to be assumed, each controlling the rhythm over a relatively small area.

RALPH S. LILLIE

UNIVERSITY OF CHICAGO

JOSEPH NELSON ROSE

1862-1928

ON the afternoon of May fourth an assembly-room in the United States National Museum was filled to overflowing in response to a call issued that morning by the secretary of the Smithsonian Institution. The gathering was called as a means of showing and recording his late associates' appreciation of Dr. Rose, who had left his desk in order late the preceding afternoon—never to return to it.

The meeting was impressive. To those of us who listened, as speakers rose here and there in the room, the kindly personality of a friend and the talented devotion of an able man to earnest work unfolded. To those of us who spoke, the sadness of the occasion was blended with a consolation born of the knowledge that a well-rounded-out life had come to ripe fruition.

I recalled that last winter Dr. Rose had reminded me of the fact that over forty years ago he had asked to do the work for his doctorate with me, but had been prevented by circumstances from doing so; and I thought of the original and thorough-going study of a difficult group of plants—the Umbelliferae—that came out of his candidacy under Professor Coulter. I remembered that when a preliminary dip into the Crassulaceae, which are ill-preserved in herbaria, had convinced me that they were beyond my own understanding, he disentangled them with masterly skill. There came to my memory a long day's tramp with him down a lava-covered mountainside bordering the valley in which the City of Mexico lies, and the keen, detailed and comprehensive way in which he examined the many agaves that we found—in which at that time he was more interested than I. Even a few days before his death he had shown me a collection of specimens and full-sized photographs of what passes for *Acacia Farnesiana*, and which for years he has known to comprise more than one species.

Interwoven with these memories were many others, like them indicative of a close observer, an energetic worker, a deliberate thinker and a friendly man even when critical.

Except for two years before attaining the doctorate, Rose was not a teacher—unquestionably to the loss of young men in whom his deliberate weighing of questions and facts would have conduced to the early formation of a judicial habit.

For forty years his connection has been with the government botanical service—first in the Department of Agriculture and later, when the present national herbarium was established under the National Museum, in this institution. To his efficiency in building up and using this great collection his associates all bear witness, and the collection itself and the long series of published "Contributions" are in evidence to the same effect; but of recent years the brunt of this responsibility has been borne by his coadjutor, Mr. Maxon.

Custodianship of a large herbarium, with an impulse to investigation, not only offers great possibilities to one who knows how to use them, but almost of necessity drives one afield. With familiarity with the contents of the larger European collections Dr. Rose also came to know many of the objects of his study in their haunts—Central and South America; and his work, especially on succulent plants, never could have acquired its lasting value in any other way. The necessary routine handling of the accessions in such an establishment as the National Herbarium affords in itself the basis of a liberal education to one keen on floristic and taxonomic studies. New material comes in from unfamiliar regions and the specimens must be named.

Among Dr. Rose's earlier tasks was naming several west-Mexican collections made by Edward Palmer, a pioneer in that field, and enumerations of such collections are among his earlier publications. It probably was in doing this work that he formed a habit of which he once spoke to me—that of synoptically bringing under his eye the characters of all the known species of a group, preliminary to naming adequately those before him; and this was a most valuable habit in his later and more difficult studies.

Though his most monumental work was on the Cactaceae, Crassulaceae, Umbelliferae and Amaryllidaceae, his interests were broadly distributed over the flowering plants. This is not the place for an enumeration of his publications, but they covered the North American representatives of Burseraceae, a considerable series of "Studies of Mexican and Central American plants," often from an economic standpoint, and a carefully executed study of the anatomical characters of certain pines applicable to their

classification—for which Engelmann had marked the way. Occasionally, as of Canby in 1904 and Greene in 1916, he wrote appreciative sketches of botanists whom he had known.

It is chiefly through his comprehensive handling of the difficult succulents, tuberose-like Amaryllids and Umbelliferae that his memory will be kept fresh in science; but those who knew him well will remember him also as a devoted public servant and a sympathetic and helpful friend, whom the last call found still active at the end of a long and successful professional career.

WM. TRELEASE

SCIENTIFIC EVENTS

THE GLASGOW MEETING OF THE BRITISH ASSOCIATION

THE British Association for the Advancement of Science has issued the preliminary program of its meeting to be held in Glasgow from September 5 to 12, under the presidency of Sir William Bragg, who in his address will deal with modern developments of the physical sciences and their relation to national problems. The subjects of the presidential addresses and discussions in the various sections include the reflection of electrons by matter, the photography and measurement of radiation, ancient geography in modern education (by Professor J. L. Myres), the nature of skill (by Professor T. H. Pear), the influence of engineering on civilization (by Sir William Ellis), the archeology of Scotland (by Sir George Macdonald) and increasing returns and economic progress (by Professor Allyn Young). Dr. Cyril Norwood will give the presidential address in the education section, which also will hold a discussion on broadcasting in the service of education, opened by Sir John Reith.

One of the customary evening discourses will be given by Professor E. A. Westermarck, on the study of popular sayings; this will be the Frazer lecture in social anthropology, which is due for delivery in Glasgow, and to which members of the association will, by the courtesy of the university authorities, be admitted. The other evening discourse will be given by Professor F. G. Donnan under the title of "The Mystery of Life," the subject being considered from the viewpoint of physical chemistry. The delegates of corresponding societies, under the presidency of Dr. Vaughan Cornish, will discuss the preservation of scenic beauty in town and country. All the meetings, except those in the evening, will be held in the university, an unusually convenient arrangement. The Lord Provost and Corporation of Glasgow will give a reception and dance in the city chambers, and the local committee a reception in Kelvingrove Art Galleries.

Ample opportunity will be provided for visits to places of scientific interest in the country around Glasgow, and for studying the manifold economic interests of the city and the Clyde area, with their many outstanding examples of the value of applied science in industry and social conditions. Saturday, September 8, is, as usual, devoted entirely to excursions, but in addition there will be numerous half-day and afternoon excursions during the week. Many of these will be of special sectional interest, or will be devoted to visits to particular works and industrial centers. The Port of Glasgow, with its quays and docks and shipyards, will be of special interest to many visitors, and to facilitate its inspection the Clyde trustees are proposing to place their steamer *Comet* at the service of members of the association.

CENTENARY OF THE LONDON ZOOLOGICAL SOCIETY

THE Zoological Society of London will celebrate the completion of its hundredth year of work next year, as it received its royal charter in 1829. The *London Times* gives the following details of the early history of the society:

As is often the case with an institution which came into existence by stages, there are several dates on which a centenary celebration might have been justified, but, as the council has announced in its annual reports for some years, 1929 was selected as the most appropriate.

The first possible date was 1822, for in November of that year some fellows of the Linnean Society, meeting at the house of William Kirby, the entomologist, gratified their discontent with the disproportionately small attention given to zoology by the Linnean Society by deciding to form a Zoological Club. They were still tied by loyalty to their parent society, and when they drafted the rules of the new body they limited membership to fellows of the Linnean Society, and arranged that their scientific work should be published by that society. The work they contemplated and for some time carried out did not include the maintenance of a living collection. There is still uncertainty over the transition from the Zoological Club of the Linnean Society to a Zoological Society with the chief object of establishing a zoological garden, and there is reason to believe that the latter had an independent origin, largely at the instigation of Sir Stamford Raffles, who, although a fellow of the Linnean Society, does not appear to have been a member of the Zoological Club.

The first known prospectus of the Zoological Society was issued in 1825 and announced as its object the formation of a society that should have the same relations to zoology and animal life that the Horticultural Society bore to botany and the vegetable kingdom. There were 77 original subscribers, among whom may be mentioned Sir Stamford Raffles, Sir Humphry Davy, president of the Royal Society, the Duke of Bedford, the Marquis of Lansdowne, Robert Peel and Alexander Baring, M.P. In this prospectus there was no suggestion of the existence

of the Zoological Club of the Linnean Society, or of limitation of the members of the new society to fellows of the Linnean Society. But there was overlapping of interest, and Mr. Vigors, who was the first secretary and last chairman of the Zoological Club, was the first secretary of the Zoological Society. The club was dissolved, apparently, in 1829, by which time most of its members had joined the new society.

A house was obtained in Bruton-street for the new society, where meetings were held, a museum established, and a certain number of living birds and mammals kept. In the course of 1826 negotiations with the Crown were successfully conducted for the use of part of Regent's Park, and the latter part of 1826 and 1827 were occupied with the laying-out of the new Zoological Gardens. Early in 1828 there were a few pinioned wild duck on a lake, an emu, an otter, some silver-haired rabbits and several birds of prey. It is reported that on February 25, 1828, there were four visitors to the gardens, but under what conditions they were admitted is not known. On April 27, 1828, a superintendent was appointed, and it was decided that visitors should be admitted on the presentation of a voucher from a fellow and the payment of 1s. Considerable progress was made during the remainder of 1828 in stocking and laying out the gardens. The first report of the council appeared in 1829, when the society received its Royal Charter, and the oldest voucher for admittance that has been traced was signed by a fellow who did not join the society until 1829.

EXHIBIT OF OPTICAL INSTRUMENTS AND PRODUCTS

UNDER the joint auspices of the Optical Society of America and the Bureau of Standards there will be an exhibit of optical instruments and optical products in the buildings of the bureau at Washington, D. C. This exhibition will be open from 9:00 to 4:30, October 31, November 1, 2 and 3 and for one evening session to be designated later by the Optical Society.

It is the desire of the committee to include in this exhibit all the newer instruments which have been developed by scientific investigators and our commercial firms. Research workers are particularly invited to contribute exhibits designed to illustrate the progress of their work and their attention is called to the fact that such an exhibit is often more useful than the presentation of a formal paper for emphasizing the significance and importance of an investigation. All American made instruments or products in which the application of optical principles is an important part in design, construction or use are eligible for exhibition. The following lists will serve to partially indicate the contemplated scope of the exhibit: optical and colored glasses, fused silica, optical components, spectacle lenses, ophthalmic instruments, binoculars, microscopes, photographic apparatus, colored photographic processes, motion-picture apparatus, astro-

nomical instruments, interferometers, spectral apparatus, metrological instruments, surveying and nautical instruments, search lights, telescopic gunsights, photometric apparatus, optical pyrometers, colorimetric instruments, vacuum discharge tubes, special systems of illumination, etc.

I. C. GARDNER, *Chairman,*

Committee on Optical Instruments Exhibit

BUREAU OF STANDARDS

THE PLACE OF SCIENCE IN EDUCATION

THERE has just been published a report of the committee of the American Association for the Advancement of Science on "The Place of Science in Education."

This report is organized under seven headings as follows and the summarizing sentence is given for some of them:

I. The Committee's Understanding of its Functions.

II. The Search for Enduring Facts and the Growth of Confidence in the Guidance of Scientific Truth. Science instruction both in school and out needs better organization, more effective cooperation to make even the health knowledge now available function more completely in the lives of people generally.

III. Obligations of Science Knowledge. Science, not to be discredited, must devise effective ways and means of developing, in its devotees first and in the whole people ultimately, a sense of moral obligation that will prevent the newly acquired knowledge and method of science serving base ends.

IV. The Science Subjects in Educational Programs. The hopeful element is that the stereotyped science courses of the college are being replaced in the earlier years at least by new types, tentative at present but frankly experimental, looking toward a more satisfactory college science sequence. The whole problem needs careful study.

V. Summaries of Types of Specific Studies Relating to the Educational Uses of Science. The above represent but a beginning in the application of the objective scientific method to the problems of science teaching. Such investigations must be multiplied and verified by those truly interested in the scientific solution of such questions.

VI. Those who Teach Science. A more thorough-going preparation in the fundamentals of science is needed by all who aspire to teach it.

VII. Those who have Developed Science. Science as method is quite as important as science subject-matter and should receive much attention in science instruction.

The committee offers the following recommendations:

(a) That some organization of national scope such as the United States Bureau of Education, or the Research Division of the National Education Association, be asked by this committee to undertake a comprehen-

sive and intensive study of the situations, tendencies and needs of science instruction in educational systems.

(b) That the services of a field secretary be secured, to work with existing agencies, to distribute information on research in science education, to stimulate further research, to operate as a sort of clearing-house agent and to continue the organizing of new groups of science teachers, writers for popularization of science, etc. This field secretary should work under the guidance of the Committee on the Place of Science in Education, or under the guidance of a national council of science teachers as soon as such a council is formed.

(c) That a national council of science teachers be organized to advance science teaching, to increase public appreciation of science and to secure for science teachers increased facilities and a wider usefulness. The services of a field secretary would be very useful in the organization of such a council.

A copy of the full report will be mailed on request sent to Elliott R. Downing, School of Education, University of Chicago, Chicago, Illinois.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM WALLACE CAMPBELL, director of the Lick Observatory and president of the University of California, received the honorary degree of doctor of science from Columbia University on June 5.

AMONG the honors listed on the occasion of the birthday of the King of England is a knighthood conferred on Captain George Hubert Wilkins, who with Lieutenant Carl B. Eielson recently flew from Alaska to Spitzbergen.

DR. G. H. HARDY, professor of geometry in the University of Oxford, and Dr. F. G. Hopkins, professor of biochemistry in the University of Cambridge, have been made foreign members of the Society of Sciences of Göttingen.

THE first award of the Dalby memorial prize, for the best original work in otology during the previous five years, has been made to Dr. Otto Mayer, of Vienna. The award is in the hands of the council of the Royal Society of Medicine, acting on the recommendation of the president and vice-president of the section of otology.

PROFESSOR LIONEL WILLIAM LYDE, professor of geography in the University of London, has been appointed a foreign member of the Hungarian Academy of Science.

DR. MAX PLANCK, professor of physics in the University of Berlin, celebrated his seventieth birthday on April 23. To commemorate this occasion his friends and colleagues have founded a gold medal to be awarded for distinguished work in theoretical physics.

PROFESSOR KARL VON NORDEN, professor of medicine at the University of Frankfurt, and Professor Friedrich Müller, professor of medicine at the University of Munich, will celebrate their seventieth anniversaries in September.

EMILE PICARD, professor of mathematics in the University of Paris, celebrated in May the fiftieth anniversary of his scientific career.

PROFESSOR HERMANN T. VULTÉ, who retires in June as professor of household chemistry in Teachers College, Columbia University, was tendered a farewell luncheon by his colleagues at the Columbia faculty house, on which occasion a gold-banded ebony cane, suitably inscribed, was presented to him. By action of the trustees Professor Vulté will continue to occupy his research laboratory.

PROFESSOR EVAN THOMAS, one of the oldest professors at the University of Vermont, retires this June under the provisions of a Carnegie pension, having completed over a quarter of a century of service at the university.

At the annual meeting of the American Society for Clinical Investigation, held in Washington, D. C., on April 30, Dr. Jonathan C. Meakins, Montreal, was elected *president*; Dr. James L. Gamble, Boston, *vice-president*; Dr. George A. Harrop, Jr., Baltimore, *treasurer*, and Dr. Joseph T. Wearn, Boston, *reelected secretary*.

At the anniversary meeting of the Linnean Society of London on May 24 the following were elected officers for 1928-29: *President*, Sir Sidney Harmer; *vice-presidents*, Dr. W. T. Calman, H. N. Dixon, H. W. Monekton and Dr. E. J. Salisbury; *treasurer*, H. W. Monekton; *secretaries*, Dr. G. P. Bidder (zoology) and J. Ramsbottom (botany).

PROFESSOR LEO EDWARD MELCHERS, head of the department of botany and plant pathology, Kansas State Agricultural College, who is on leave in Egypt, was recently made chief mycologist in charge of the section of mycology in the Ministry of Agriculture. During his stay in Egypt he is undertaking the reorganization of the mycological work for the Egyptian government. He was recently made chairman of a committee on plant quarantine and inspection work in Egypt, the plan being to improve the present service and facilities for conducting the work.

DR. B. T. DICKSON, until recently professor of plant pathology of McGill University, Canada, has been appointed chief of the division of economic botany of the Commonwealth Council for Scientific and Industrial Research of Australia, which division he is now in process of organizing. Dr. Dickson originally went to Australia to take charge of the plant patho-

logical work of the council and this is now being absorbed in the larger division.

PAUL C. STANDLEY, formerly of the U. S. National Museum, has been appointed associate curator of the herbarium in the Field Museum of Natural History, Chicago. He began work in his new position on June 1.

CLIFFORD S. LEONARD, assistant professor in the department of pharmacology and toxicology at Yale University, has joined the staff of the chemical research laboratories of Burroughs Wellcome and Company, Inc., in New York.

JAMES GIRVIN PETERS has been appointed chief of the branch of public relations in the United States Forest Service. Mr. Peters succeeds Major R. Y. Stuart, who on May 1 took over his duties as chief forester.

THE U. S. Coast and Geodetic Survey announced on June 1 the appointment of Leo O. Colbert as director of coast surveys of the Philippine Islands, to succeed R. B. Derickson, who will be assigned to other duty.

DR. S. HERBERT ANDERSON, associate professor of physics at the University of Washington, has been granted a year's leave of absence to engage in research work for the Guggenheim Foundation of New York. His studies will concern the field of sound as related to aeronautics to develop instruments for landing in fog and other safety devices. He will report at Wright Field, Dayton, the army engineering headquarters, on July 1.

AUGUST F. FOERSTE, of Dayton, who was granted an award from the Marsh fund by the National Academy of Science, sailed on June 8 to spend the summer visiting collections and field localities in northern Europe.

FRANCIS J. PETTIJOHN, on leave for study from the department of geology, Oberlin College, will spend the summer studying the ancient crystallines near Sioux Lookout, Ontario. He will be accompanied by Mr. Walter Chappel, a recent Oberlin graduate in geology. The work will consist of a reconnaissance survey, followed by an intensive study of the critical areas.

HUGO WINKENWERDER, dean of the college of forestry at the University of Washington, left on May 26 for Europe, where during the summer he will make a study of botanical gardens and ancient forests.

THE department of vertebrate paleontology of the American Museum of Natural History is sending out three men, Peter Kaisen, Ernest Kaisen and Glen Streeter, to cooperate with the Colorado Museum of

Natural History in completing the Folsom, New Mexico, bison excavations, noted because of the association of human artifacts with an extinct species of bison.

DR. ALBERT ERNEST JENKS, professor of anthropology in the University of Minnesota, will head an expedition which was to leave about June 10 by motor and railroad to dig for six weeks in the Mimbres Valley, New Mexico, where they expect to find traces of prehistoric culture.

PLANS for an expedition this summer to study marine sedimentation and its influence on ocean life at the West Indies, with Dr. William Beebe, of the New York Zoological Society, and Dr. Charles Fish, director of the Buffalo Society of Natural Sciences, among its members, have been announced by Professor Richard M. Field, of the department of geology at Princeton University.

DR. HENRY J. COX, of the United States Weather Bureau, has been appointed a delegate of the Geographic Society of Chicago to the International Geographical Congress, which meets in London and Cambridge, England, from July 13 to 26. He has also been named as a delegate to the same congress by the National Academy of Sciences and National Research Council in Washington.

PROFESSOR CHARLES P. BERKEY, professor of geology in Columbia University, has been invited to take part in an arranged discussion on the geology of Central Asia at the meetings of the British Association for the Advancement of Science, which will be held in Glasgow next September. Professor Berkey will attend the convention as an official delegate of the American Museum of Natural History and of Columbia University.

DR. G. STRUVE, director of the Berlin University Observatory at Neu-Babelsberg, Germany, arrived in the United States on June 4. Dr. Struve came at the invitation of the University of Chicago and of Yerkes Observatory, of which he was recently nominated honorary research associate professor. He will also visit the Lick Observatory.

DR. HANS WILDBOLZ, professor of surgical and diagnostic urology in the University of Berne, gave a Mayo foundation lecture on June 7, at the Mayo Clinic, Rochester.

PROFESSOR G. W. RITCHEY, of the Solar Observatory, Pasadena, delivered an address on May 11 before the Royal Astronomical Society, in which he explained the method of the construction of "cellular" mirrors carried on at the Paris Observatory. On May 16, Professor Ritchey spoke on "The Modern Reflecting Telescope," before the Optical Society in the Imperial College, South Kensington.

DR. GEORGE C. SHATTUCK, assistant professor of tropical medicine at the Harvard Medical School, gave a lecture in London, on May 21, on his recent expedition to Liberia and the Congo, before the Royal Geographic Society.

PROFESSOR W. F. G. SWANN, of the Bartol Research Foundation, addressed the colloquium at the Bell Telephone Laboratories, New York City, May 28, on "Possible Modifications in Electrodynamics and Their Consequences."

ARTHUR E. MORGAN, president of Antioch College, formerly chief engineer of the Miami Conservancy District, addressed a meeting of the geology section of the Ohio Academy of Science, June 2, on the subject of the problems connected with flood prevention in the Dayton area.

THE surgical papers of Dr. William Stewart Halsted, who died in 1922 and who was for thirty-two years surgeon-in-chief of the Johns Hopkins Hospital, have been published in two volumes as a tribute to his memory.

A MEMORIAL volume, containing more than 200 pages with photographs, prepared by employees of the Panama Canal to commemorate the life and works of the late Major-General George W. Goethals, has been sent to his widow.

THE one hundred and twenty-fifth anniversary of the birth of the chemist Justus Liebig, who was born at Darmstadt, is to be celebrated by rebuilding with the original material the house in which he was born, and the addition to it of a museum.

DR. HOWARD A. LOTHROP, professor of surgery at the Harvard Medical School, died on June 4, at the age of sixty-four years.

WILLIAM EDWARD PLUMMER, director of the Liverpool Observatory, died on May 22, aged seventy-nine years.

DR. F. M. PERKIN, of England, one of the founders of the Faraday Society, died on May 24.

THE deaths have been announced of the following German scientific men: Dr. Otto Staude, professor of mathematics at the University of Rostock; Dr. Gustav Schultz, professor of chemical technology and metallurgy in the University of Munich; Dr. Johannes Gadamer, professor of pharmaceutical chemistry in the University of Marburg, and Dr. Julius Hirschwald, professor of mineralogy and geology in the University of Berlin.

PROFESSOR OTTO NORDENSKJOELD, well-known Swedish Arctic and Antarctic explorer and professor

at the University of Gothenberg, died on June 2, at the age of fifty-nine years.

THE Pacific section of the American Association for the Advancement of Science is meeting at Pomona College from June 13 to 16. Various affiliated societies are holding their meetings in conjunction with it, including the Astronomical Society of the Pacific, the American Meteorological Society, the American Physical Society, the Pacific sections of the American Chemical Society, the American Association of Economic Entomologists, the Botanical Society of America, the Western Society of Naturalists, the Society for Experimental Biology and Medicine and others. The meeting is presided over by the president of the section, Dr. Charles A. Kofoed, professor of zoology at the University of California. On Wednesday evening, June 13, he delivered an address on "The Luminescence of the Sea." Other general lectures are to be given by Dr. F. H. Seares, assistant director of the Mt. Wilson Observatory, on "Counting the Stars," and by Dr. Charles K. Edmunds, president of Pomona College, on "Some Physical Features of China."

PROBLEMS confronting federal, state and local health authorities, including prevalence of leprosy in the United States, the present status of trachoma and its treatment, the relation of iodine to goiter, and other public health matters of mutual concern, were considered by the joint sessions of the annual Conference of State and Provincial Health Authorities of North America, meeting in Minneapolis, June 8 and 9, under the auspices of the United States Public Health Service.

THE fourth Pacific Science Congress will be held at Batavia, Buitenzorg and Bandoeng, Java, during May and June, 1929, under the auspices of the Pacific Science Association. The general president of the congress and chairman of the Netherlands Indies Pacific Research Committee is Dr. A. A. L. Rutgers.

AT a general meeting of members of the British Institute of Metals on May 8, an invitation was presented on behalf of the American Institute of Mining and Metallurgical Engineers for the Institute of Metals to visit America and meet with the American body in 1932. According to the *Electrical Review* the president of the institute, Dr. W. Rosenhain, F.R.S., suitably acknowledged the receipt of the invitation, and indicated that it would be gladly accepted by the institute.

PLANS for the twenty-third International Congress of Americanists, to be held in New York the week of September 17, have been announced. The congress,

which holds biennial sessions, is devoted to the study of the peoples of pre-Columbian America, both ethnically and from the point of view of environmental factors. Sessions of the congress will be held at the Natural History Museum, at the Museum of the American Indian, at Columbia University, and at the Brooklyn Museum. The program includes general and sectional meetings and various entertainments. Henry Fairfield Osborn is chairman of the honorary committee and Franz Boas of the organizing committee. Other members of the latter committee include George G. Heye, Stewart Culin, A. V. Kidder and P. E. Goddard. Two previous meetings of the congress have been held in this country: the thirteenth in New York in 1902 and the nineteenth in Washington in 1915.

FOLLOWING the action taken by the executive board of the National Research Council on April 24, that the National Research Council adhere through its division of geology and geography to the International Geographical Union, the following seven delegates have been named to the International Geographical Congress to be held in London and Cambridge from July 14 to 25: Dr. Wallace W. Atwood, president and professor of physical geography, Clark University; Colonel C. H. Birdseye, chief topographic engineer, U. S. Geological Survey; Dr. Isaiah Bowman, director of the American Geographical Society, New York City; Dr. Albert P. Brigham, professor of geology in Colgate University; Dr. Henry J. Cox, senior meteorologist, U. S. Weather Bureau, Chicago, Ill.; Dr. Douglas Johnson, professor of physiography, Columbia University, and Colonel E. Lester Jones, director of the U. S. Coast and Geodetic Survey.

THE United States Civil Service Commission announces an open competitive examination for senior physicist, applications for which must be on file with the commission at Washington not later than July 5. The examination is to fill a vacancy at the Signal Corps Laboratory, Monmouth, N. J., and vacancies occurring throughout the United States in positions requiring similar qualifications. The entrance salary for this position in the departmental service in Washington, D. C., and of the present vacancy in the Signal Corps Laboratory at Monmouth, N. J., is \$5,200 a year. Competitors will not be required to report for examination at any place, but will be rated on their education and experience, and writings to be filed with the application.

ACCORDING to the annual report of the Rockefeller Foundation, the following medical schools were assisted during 1927: State University of Iowa, University of Montreal, National School of Medicine and

Pharmacy, Haiti; Faculty of Medicine, São Paulo, Brazil; University College, London; London Hospital Medical School, University of Cambridge, University of Edinburgh, University of Lyon, Free University of Brussels, University of Strasbourg, twenty departments in twelve French and Italian medical schools, Institute of Psychiatric Research, Munich; University of Zagreb, American University in Beirut, Chulalongkorn University, Bangkok; Shantung Christian University, Tsinan; Shanghai Union Medical School, Hsiangya Medical College, Changsha; Keio University, Tokyo.

Two prizes are offered by the Eugenics Research Association for the best essays written by an American author and two prizes for essays written by European authors on the topic: "A comparison of both the crude birth-rate, the birth-rate per 1,000 females 15 to 45 years of age, and the 'vital index' (or 100 births/deaths ratio) of the Nordic peoples and non-Nordic peoples in the Americas." Data are to be considered in different periods from 1850 to the present time, or that of the last available census or registration. Nordic peoples in the Americas are considered to be those whose ancestors came mainly from Nordic countries. For the purposes of this investigation Nordic countries are defined as including the Scandinavian countries south of about 63° N. lat., the Netherlands, England, Scotland, North Ireland and the German States of Schleswig-Holstein, Mecklenburg, Hannover and Westphalia. Any other section of Europe, any part of Asia and Africa north of the Zambezi, may be regarded, for the purposes of this study, as "non-Nordic." The prizes offered in each of the two groups are: \$1,000 for the best essay and \$200 for the second best. The essay is to be type-written and mailed in time to reach Cold Spring Harbor by February 1, 1929. Further details may be obtained by addressing the Eugenics Research Association, Cold Spring Harbor, Long Island, New York.

THE sea life along the Great Barrier Reef will be studied by a British expedition that sailed for Australia on May 26. Naturalists of the expedition staff will investigate the composition and formation of the enormous coral reef and feeding habits of the sea animals. They also hope to study the commercial possibilities of the region, including oyster, pearl, turtle and trochus shell resources. The expedition, which will be in the field for one or two years, is headed by Dr. C. M. Yonge, naturalist, who has been on the staff of the Marine Biological Association. The project of studying the coral reef was promoted by the British Association for the Advancement of Science, and a number of scientific organizations have subscribed to it.

UNIVERSITY AND EDUCATIONAL NOTES

A GIFT of \$100,000 has been made by Mr. and Mrs. R. T. Crane, Jr., Ipswich, Mass., toward the endowment of the department of therapeutics of New York University and Bellevue Hospital Medical College.

THE University of Southern California plans to ask the medical profession of Southern California to raise \$500,000 for the endowment of the new medical school which will open in September. An entire new faculty is to be appointed in the reopening of the medical school. The appointment of the full-time professors for the preclinical work will be made in the next few months.

THE corporation of Yale University has increased by \$500 the salaries in each grade of the assistant professorships and associate professorships and has raised the minimum salary for full professors from \$5,000 to \$6,000.

CAPTAIN EDWARD STEIDLE, of the Carnegie Institute of Technology, has been appointed dean of the school of mines and metallurgy at the Pennsylvania State College.

DR. JOHN FRAZER, professor of chemistry and for the past sixteen years dean of the Towne Scientific School of the University of Pennsylvania, has resigned as dean in order to continue his teaching and to devote himself to research in chemistry. He has been granted a leave of absence for the coming year.

DR. ROBERT CHAMBERS, JR., professor of microscopic anatomy in the Cornell University Medical College, has been appointed by New York University to be chairman of the department of biology and research professor of biology at its Washington Square College.

DR. SYDNEY W. BRITTON, associate in physiology at the Johns Hopkins University, will leave at the end of the scholastic year to become professor of physiology at the University of Virginia Department of Medicine, Charlottesville.

DR. SHERMAN C. BISHOP, zoologist in the New York State museum since 1916, has been appointed professor of zoology in the department of biology at the University of Rochester.

DR. JOHN G. SINCLAIR, of the department of anatomy at the University of Wisconsin, will go to the University of Texas as associate professor of embryology and histology in the medical school at Galveston, Texas.

PROFESSOR J. M. BRYANT, of the University of Texas, has been appointed professor of electrical engineering and head of the department at the University of Minnesota. Professor I. M. Kolthoff, of the

University of Utrecht, Holland, has been appointed professor of analytical chemistry and chief of the division.

DR. ARTHUR T. EVANS, for the past five years head of the department of botany and plant pathology at South Dakota State College, has resigned to become head of the department of botany at Miami University, Oxford, Ohio.

AT the University of London the following appointments have been made: Dr. Percival Hartley, of the National Institute of Medical Research, has been appointed to the university chair of biochemistry tenable at the London School of Hygiene and Tropical Medicine. Dr. C. B. Fawcett, reader in geography in the University of Leeds, has been appointed to the university chair of economic geography tenable at University College. Dr. Geoffrey Hadfield has been appointed to the university chair of pathology tenable at the London School of Medicine for Women.

DISCUSSION AND CORRESPONDENCE

OVARIAN SECRETION AND TUMOR INCIDENCE

IN SCIENCE for April 13, 1928, Dr. W. S. Murray¹ has published, in reply to my note in SCIENCE of January 27, 1928,² a second article on the relation between the internal secretion of the ovary and the origin of tumors of the mammary gland in mice. Inasmuch as the statements of this author as to the facts, on which the proof of the significance of internal secretions of the ovary for the development of mammary cancer in mice is based, are incorrect, and in particular as his statements as to my work concerning this problem are incorrect, I feel constrained to state briefly what I believe to be the correct interpretation of the facts in this case.

(1) According to Dr. Murray, in my series of experiments (published twelve and nine years ago),³ my own figures prove that the reduction of tumor rate through castration on the one hand, and through prevention of breeding on the other hand, are of approximately the same order. This conclusion is made possible only by adding together all my castration experiments, irrespective of the time at which the castrations were carried out. This is a procedure which is misleading, the inadvisability of which I have emphasized in my paper published nine years ago. There I pointed out that mice castrated at the age of three to four months remain practically free from tumors. There was one doubtful case among fifty-four castrated animals between the age of three and six months

¹ Murray, W. S., SCIENCE, 66, 600, 1927, and 67, 396, 1928.

² Loeb, Leo, SCIENCE, 67, 104, 1928.

³ Loeb, Leo, *Am. Journ. Cancer Research*, 1, 1, 1916, and *Journal of Medical Research*, 40, 477, 1919.

in which a tumor arose, and, as I then stated, there was some reason for believing that in this instance we had to deal with an animal which was older than four months. But even conceding that there developed one tumor among fifty-four castrated mice, we would have accomplished through castration in mice, at an early stage of sexual maturity, a reduction in the tumor rate from 68 per cent. to 1.8 per cent. These results, and similar ones obtained by Cori,⁴ whose mice were castrated at a still earlier period of life and remained entirely free from tumors, show that castration carried out in early life, by removing the cyclic stimuli exerted on the mammary gland through internal secretions given off by the ovary, prevents the development of mammary cancer in mice, which otherwise were destined hereditarily to have a higher tumor rate.

There was in addition one group of seventeen mice castrated between the age of four to six months, among which there were therefore no mice younger than four months; in this group there appeared four tumors. If we include this group among the animals castrated between the age of three to six months we obtain five mice with tumors among seventy-two castrated mice; this corresponds to 7 per cent. It is only if we castrate mice fully six months old or older that the incidence of cancer becomes higher.

(2) This is a result totally different from the effect produced through prevention of breeding. Through the latter procedure it was possible, in these investigations carried out by Miss Lathrop and myself, to effect in some strains a reduction of 30 per cent. or slightly more; but in other strains the reduction was much smaller. In one strain of non-bred mice there was even an increase in the tumor rate, partly owing to the increase of length of life due to non-breeding. On the average the tumor rate of the mice belonging to families with a high tumor rate fell to about 30 per cent. and in one case to about 23 per cent., while in other cases it remained considerably higher. In general, in non-breeding mice the tumor appeared later in life than in mice which were bred. Different strains varied as to the effect of prevention of breeding on the cancer rate, but we did not obtain by these means a diminution of the tumor rate below 20 per cent. In the strain used by Dr. Cori the non-breeding caused only a slight reduction in the tumor rate.

The fact, shown in my previous experiments, that prevention of breeding, in general, reduces the tumor rate, although to a less extent than early castration, proves that, in addition to the cyclic stimuli exerted by other ovarian structures, also the stimuli given off by the internal secretion of the corpus luteum and the stimuli associated with the abrupt cessation of the

action of the corpus luteum following the preceding growth period, may play a rôle in the development of mammary carcinoma in mice.

(3) As I pointed out in my previous note, I attempted to confirm the results thus obtained through transplantation of ovaries into castrated male mice belonging to strains with a high incidence of cancer. Owing to conditions over which I had no control, the number of experiments had to be limited and I obtained therefore negative results. Murray, in operating upon a much larger number of male mice, succeeded in obtaining positive results in a small minority of his animals. I consider his results as a valuable contribution to this problem; however, as far as the main point at issue is concerned, the importance of the internal secretion of the ovary in the production of mammary tumors in mice and of the quantitative interaction of these substances with hereditary factors, this had been demonstrated conclusively through our earlier experiments and it has been confirmed by the work of Cori.

(4) As far as the stock of mice is concerned which served for these experiments and which is referred to by Dr. Murray, I may state that I observed personally not only the mice castrated by myself previously, but also certain control mice which developed tumors under conditions under which the mice castrated, at an early period, remained free from tumors.

I may further state that the investigations on heredity of mammary cancer in mice, on which the experiments concerning the action of internal secretions were based, were jointly carried out by Miss Lathrop and myself. While the mice used for breeding were almost exclusively attended to personally by Miss Lathrop, I visited the breeding establishment from time to time, and had occasion to convince myself of the untiring energy, care and trustworthiness with which Miss Lathrop carried out the breeding experiments which I had suggested and in which she was deeply interested. In many cases, I controlled the results as to the development of tumors through autopsies performed on this stock, and if a mistake did happen Miss Lathrop made it a point to inform me of such an occurrence. I have no doubt that the care which Miss Lathrop gave to the actual breeding of the mice was vastly superior to the attention which an ordinary attendant in laboratories is accustomed to give to such work; and it is on the cooperation of others that investigators have to rely in breeding experiments which are carried out on a large scale. Furthermore, in its important aspects the results which we have obtained as to the hereditary transmission of tumor rate in distinct strains of mice have been confirmed by subsequent investigators, a fact which may be considered as a proof that the breeding

⁴ Cori, C. F., *Journ. Exper. Med.*, 45, 983, 1927.

experiments had been carried out with the necessary care.

(5) In these investigations we considered it sufficient to divide the mice to be used in the castration experiments into age groups covering in some cases two, in other cases three months periods. For statistical purposes, I combined these mice into one class, including the mice between three and six months of age. However, Miss Lathrop kept a record of the time of birth of each litter used in our work on the heredity of cancer in mice, and there is no justification for the conclusion on the part of Murray that such records were not kept. As to the mice which were castrated at this age (between three and six months), they had been prevented from breeding previous to the operation; but if, contrary to our plans and knowledge, they should have bred, the result of castration in preventing the development of mammary cancers in these mice would have been the more striking.

(6) In conclusion I may state again that the investigations, on which Murray reports, without exception represent the type of experiments which I had carried out previously and that through this earlier work the significance of the various internal secretions, given off by the ovary, for the development of mammary cancer in mice had been proven.

LEO LOEB

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THE RING METHOD IN CHANGING SURFACE TENSION

I HAVE just seen a very excellent paper by S. L. Bigelow and E. R. Washburn, published in the *Journal of Physical Chemistry*, on "Variations in the Surface Tension of Solutions."

It is a great pleasure indeed to read such a reliable and conscientious piece of work. I hope the authors will find it natural that I should explain a statement which I made somewhere and which they quote as "remarkable," not in the complimentary sense of the word, I am afraid. The sentence read: "It is only through the ring method that it is possible to observe and study this phenomenon (changing surface tension) as it is the only procedure which permits the measurement of surface tension of the same layer of liquid at very short intervals." This statement is not accepted by the authors of the paper, who decide that it is "manifestly in error," and they are quite surprised that I should have found anything by this method.

In the first place, they are right, as it is obviously not the "only" method whereby such changes can be

observed, but I maintain that it is the only one which, as I said, makes readings possible at "very short intervals." Of course we may not call "very short intervals" the same thing. What I meant were intervals of the order of one second and less. I have published in my book experiments where eight measurements were taken in the first minute. The technique is described in the same volume. That, I still believe, is impossible with the capillary method. Furthermore, if Messrs. Bigelow and Washburn had read the afore-said book carefully, they might have understood how it was I managed to observe phenomena which they confirmed: "Pulling off a ring, they say, and replacing it must seriously upset any molecular arrangement in the surface . . ." Well, it does, but I did not always pull it off and replace it. I used a different sample of the same solution for every measurement. The ring was pulled off only once.

However, I must add that, even when such precautions are not taken, the phenomenon of time-drop can be followed, but not as accurately, of course.

LECOMTE DU NOÛY

INSTITUT PASTEUR, PARIS

"NUTRILITES"

THE term "vitamine" was introduced by Funk to designate those unknown factors in nutrition which were thought to prevent various diseases. This term with a modified spelling has become widely adopted in spite of its obvious defects. The term has been applied in some cases to unknown substances which in small amounts are effective in the nutrition of fungi (including yeast), bacteria and other organisms. At present, however, the tendency is to restrict the use of the word "vitamin" entirely to substances concerned in *animal* nutrition.

The word "bios" was introduced by Wildiers to designate an unknown substance which in small amounts stimulates yeast growth. The word "auximones" was likewise introduced by Bottomley to designate substances of a similar nature which were thought to be effective in the nutrition of certain green plants. It is increasingly apparent that there are unknown factors which function in the nutrition of many types of organisms. It is also obvious that there is need for a general term to designate these factors. Otherwise it will be necessary to invent new names for substances found to be effective in the nutrition of bacteria, molds and other forms of life. None of the terms in use at present applies.

It is suggested that the word "nutrilite" be used to designate all those vitamin-like substances which in small amounts function in the nutrition of organisms in general. The term has the advantage that it indi-

cates that the substances function in nutrition, but does not indicate in advance of our knowledge *how* they function. The term makes no extravagant claim as to the indispensability of the substance or to any peculiar relationship to life, as unfortunately the terms "vitamin" and "bios" do. In form the new word is similar to the word "metabolite." There is a closely related word already in the dictionary, "nutrility," which pertains to nutrition, but is rarely used.

We may then define a nutrilitate as a substance, other than the well-recognized nutrients, which functions in small amounts in the nutrition of organisms. It is to be expected that borderline cases will appear in which it will be difficult to decide whether or not the material in question should be regarded as a nutrilitate. This will not seriously impair the usefulness of the term, however, since a similar situation exists in the case of many words such as, for example, "carbohydrate" and "alkaloid."

ROGER J. WILLIAMS

UNIVERSITY OF OREGON

AN ANCIENT WALRUS SKULL

A RATHER interesting find, in the nature of an ancient walrus skull, recently made on Georges Bank off Cape Cod, has been presented to the Boston Society of Natural History. The skull, consisting of the fore part with tusks, which are twelve and fourteen inches long, and most of the flat-crowned crushing teeth of the upper jaw still in place, belongs to an animal now unknown as far south as the New England coast.

It has not been determined how this skull came to be on the bank, nor is it known how long it may have lain on the sea bottom, but it is probable that it came there two hundred and twenty or three hundred years ago. The walrus occurred, during the Ice Age, as far south as Virginia and the Carolinas, where fossil remains have been reported; in the seventeenth century it was found on Sable Island, off the coast of Nova Scotia, while during the last century it was quite common in the Gulf of St. Lawrence and on the shores of Labrador. It is quite possible at that time some of them may have visited the waters of the Gulf of Maine, or even strayed as far south as the Georges Bank, and that the specimen recently found belongs to one of these.

BIRGER R. HEADSTROM

MEDFORD HILLSIDE,
MASSACHUSETTS

THE ROYAL PHOTOGRAPHIC SOCIETY

The Royal Photographic Society of Great Britain is holding its seventy-third annual exhibition in September and October of this year. It is hoped that the

American representation in the scientific section will be such as to demonstrate the place held by this country in applied photography. I am collecting and forwarding American work for the scientific section again this year. Exhibits should consist of prints showing the use of photography for scientific purposes and its application to spectroscopy, astronomy, radiography, biology, etc. Photographs should reach me not later than June 8, and should be mounted but not framed. There are no fees.

A. J. NEWTON

EASTMAN KODAK Co.,
ROCHESTER, N. Y.

LOW HUMIDITY AND HIGH TACITURNITY

ARIZONA is perhaps best known in the demi-lands of letters as the abode of strong, silent men. So steeped in sentimentality is the lore of their laconism that a pragmatic interpretation has become imperative.

The low humidity of Arizona is almost as proverbial as the silence of her strong men. This is no mere fortuitousness. For low humidity begets parched throats, and it is axiomatic that a desiccated larynx and a vociferous tongue are incompatible.

A practical application suggests itself. Repression of verbosity has been, at times, a problem of national concern, actually jeopardizing the Senate rules. The atmosphere of the district is notoriously humid, and in such an environment loquacity thrives. But to euthenics there is available an effective antidote, a local anesthetic of uncanny selectivity. Even the most garrulous of filibusters could be silenced quickly by the aid of a potent air-dehumidizer.

E. A. VUILLEUMIER

DICKINSON COLLEGE

REPORTS

HORIZONTAL VERSUS VERTICAL FORCES IN CRUSTAL MOVEMENTS OF THE EARTH

PROFESSOR BAILEY WILLIS, of Leland Stanford University, and now president of the Geological Society of America, addressed the Boston Geological Society on January 11, 1928, on "Horizontalist or Verticalist?"

The doctrine of the direction of forces causing diastrophism is a question of faith. Willis stated that he was brought up a horizontalist, and in 1876 G. K. Gilbert had told him to study Appalachian structure, and he was carried far in seeing the effects of horizontal thrusting. On later expeditions into the Alps, the Andes and into Patagonia Willis found his faith in horizontalism supported. Later he went to California, where Gilbert had studied the structure of

the Basin Ranges and had concluded that there the forces had acted upward from below. Willis first accepted the fact that the Sierra Nevada had been tilted but not deformed.

Louderback had described normal faults, arranged as step faults, dipping east, along the eastern front of the Sierra Nevada, and which there bound the range. Willis considered these as superficial slides into the eastern basin, and that the tilting of the mountain had been accomplished by rotation of the mountain block on a rounded base by a horizontal force from the west.

Two recent field seasons in Owens Valley and Mona Lake country along the east base of the Sierra Nevada showed Willis that the normal step faults are but minor slips, and the crest of the range is not the top of the fault scarp, but the top of an arched surface. The arch ends at an elevation of nine thousand feet on the east side, and from there the blocks on the east dip into the valley. The main fault is curved back toward the west beneath the range. The westward back slope of the main range instead of being merely tilted is curved, or domed, and is intersected by faults with throws as great as a thousand feet.

Willis coupled these observations with studies made in tunnels and drifts in the serpentine of the New Almaden mine where the rocks display an extreme squeezing beneath the Sierra Nevada. He thus conceived that the main force was horizontal, and was a tremendous deep-seated thrusting from the west against a stable block on the east. The rocks were squeezed as in a vise. A component of the pressure was necessarily upward, doming the Sierra Nevada upland, and lifting the blocks along faults, which instead of being normal faults are reversed upthrust faults.

This conception took Willis back to his experiments of wax and turpentine made in 1887 and 1888, in which he reproduced the folding of the Appalachian type. The lower surfaces of the material yielded by shear, and shearing planes developed at 45 degrees to the shearing force and caused displacements on a relatively large scale.

If the upswelling is due to a movement in a deeper zone, it must have been due to the conversion of a deep-seated crystalline rock into a gneiss, with vertical schistosity. In order to test this theory, Willis kept the problem in mind on a recent trip around the world. He had become a horizontal verticalist, because he saw how vertical movements of the earth's crust could result from horizontal compression.

During his visit to Japan, he examined the ranges of Hokkaido, the northern island of Japan. The central range, about seven thousand feet in height,

is deeply dissected and rugged, revealing complexly folded Paleozoic sediments injected by tongues of granite. The block as a whole has an arched appearance. West of the range, Cretaceous beds are folded and overthrust westward toward Asia. They abut on the west against folds of early and mid-Tertiary strata, which have a more simple structure, but are also overturned toward the continent. Still farther west on the same island the folded Tertiary zone is succeeded by a platform of uplifted, but nearly horizontal Pliocene beds, from which one descends to the coast.

A Paleozoic geosyncline, folded and intruded by granite, must have been peneplaned during the Mesozoic time. Then a new Cretaceous geosyncline formed west of it, and received its fill of sediments, and was in turn folded, by pressures which arched up the Paleozoic mass on the east. The cause of this swelling was the shearing and the development of schistosity in deep-seated crystalline rocks. The active force had come from the Pacific. A third geosyncline formed during the Tertiary time and west of the Cretaceous folds; and having received in turn its load of sediments, was folded before Pliocene time. The fourth, or Pliocene trough, has not yet been folded.

The presence of folds en echelon, especially in the newer Japanese arcs, points to their lying in the shear zone between two rounded disc-like blocks—the one under the Pacific and east of northern Japan, the other under the Asiatic continent. The rotation of both blocks in a clock-wise direction has developed the shearing and folding en echelon between them. The location of granite intrusions in northern Japan was determined by tension.

In the southern island of New Zealand, Willis made a section westward from Dunedin. On the eastern half of the island there is an elevated plateau separated by a deep valley from the Southern Alps to the west. The plateau is broken in an irregular fashion by rift valleys described by Cotton. The plateau is underlain by mica gneisses, as Willis termed them—rocks with horizontal banding but in which the sedimentary structures are preserved. The Southern Alps he found to be a tightly compressed isoclinal fold, which must have been an old fold. On the west side of the range there is a shear-zone recorded by networks of quartz veins, while shatter-zones reveal the modern revival of shearing. The region is probably underlain by a batholith of late Paleozoic age. Willis pictures the movements as being mainly a horizontal thrust from the east, along the curving thrust-plane which dips from the western side of the range and eastward under the range. As

a component of this thrusting there was a vertical uplift of the plateau, due mainly to shearing in the mechanical zone.

The island of Cyprus, in the eastern Mediterranean, Willis found to be of especial interest to him who seeks horizontal forces. Three main structural elements are found in the island; in the north an east-west range of mountains; in the south a higher and broader range, and between them a central plain or lowland. The northern range includes Cretaceous Oligocene sediments, folded and faulted. The central lowland is of tilted and beveled Miocene shales and limestones, overlain unconformably by the horizontal Pliocene. In the Miocene sediments at the foot of the northern range, there is a marvelous exhibition of crushing. The southern massif is the famous Mt. Troodos, the old Olympus of Greek mythology. It is a mass of hornblende igneous rock, an old plutonic mass, now gneissic.

There has been a thrusting from the north, so that the northern mass has been moved southward. There are no faults in the Miocene central plain except normal faults due to tension. The Miocene dips northward off the northern flank of Mt. Troodos at about 15 degrees, and the rocks have been stretched. The upland of Mt. Troodos is a smoothly rolling mature-land, and on it the ancient Miocene shoreland is approximately indicated by a longitudinal valley, high up on the flank of the mountain, where, banked in by the former cuesta front of the Miocene, a subsequent river has cut a trench into the crystallines of the Troodos massif.

This old shore-line indicates that there was a vertical movement of Mt. Troodos, probably as much as four thousand feet, while twenty miles to the north there is a great overthrust. Here, therefore, is another example of vertical movement in connection with great horizontal compression. The great movement came from the north and was deep-seated (the overthrusting of the northern range is only a shallow expression of it) and as a result of the development of gneissic structure in the Troodos mass in response to the horizontal compression, the southern part of the island was considerably uplifted.

In response to questions on the Cyprus mass, Willis said that he thought that the movements were still going on in Cyprus, of which the recent destructive earthquake of Salamis is testimony. This raised the question of the cause of destructive earthquakes. Willis stated that in his opinion such earthquakes are not the result of slight movements on normal faults, but rather the elastic spring of rocks, from the energy stored up in them through years of compression.

Willis stated that he thought the thrusting upward of a piston of crystalline rock, like that at Mt.

Troodos, with a drag along the side of the piston, and consequent removal of material from beneath the contingent areas of the lee side, away from the side of active horizontal pressure, is the cause of subsidence, and the formation of geosynclines.

A lively discussion by Professors Lane, Daly, Terzaghi, Collet, Morris and Dr. Boydell followed Professor Willis's address.

JOSEPH L. GILLSON

BOSTON GEOLOGICAL SOCIETY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF THE X-RAY IN BIOLOGICAL INVESTIGATIONS

THOUGH X-ray pictures have been generally adopted by the medical sciences, they have been little used in the descriptive natural sciences where I believe they would greatly facilitate studies. A picture may save months of painstaking technical work. For students it would save the laborious work of microtomy and the subsequent reconstruction of organs from sections.

By using this method many a valuable organism can be kept intact that otherwise would have to be sacrificed for the purpose of study.

As far as I know, X-ray pictures have been used in zoology and botany only by a few workers and by them in only a small way. Probably the first to use them was Dr. David Starr Jordan, who reproduced X-ray photographs of fishes, but confined himself in the main to showing the pictures without giving a detailed description of the objects represented.

One of the main reasons why this method has been so little employed by biologists is the fact that its use necessitates expensive apparatus and that the pictures have to be made by carefully trained experts, who are thoroughly familiar with all the details of the process. In addition to that, the pictures themselves are quite expensive, and as a consequence only institutions with large available funds are able to undertake the work.

Because of the splendid cooperation between the Queen's Hospital and Bernice P. Bishop Museum of Honolulu, I have been able to realize my ambition to study by means of X-rays the majority of the representatives of the ichthyological fauna of a relatively large area and also to make observations and experiments regarding the adaptability of this method to biological studies as a whole.

An undeniable advantage of the Roentgen method, as compared with all others, is that every bone, even the finest, may be seen in its natural position. Even the intermuscular ossifications not connected with the skeleton can be clearly observed; whereas by any other

known method their accurate position in relation to the rest of the body can be determined only with the greatest difficulty. Even while dissecting in the most careful and exact manner, one can not avoid cutting off some very fine points of the ribs or projections from some other bones. An X-ray picture makes this unnecessary.

The X-ray picture would be especially valuable for studying fossils; above all for the study of fossil fishes. An X-ray picture resembles such a fossil much more than a skeleton without any of the soft parts could possibly do. While these parts are rather dim on the negative, they are sharply circumscribed and remind one of the shape of the fossilized animal, whose outlines and soft parts of the body can only be distinguished by a discoloration of the stone.

In differentiating a number of closely related species of the same genus, whose only differences consist in colors and small dissimilarities of the body, the paleontologist is faced with an extremely difficult problem. It might be said that, in the meaning applied to living species, such a procedure is futile. By means of X-ray pictures *real* species distinguish themselves through constant differences between each other (small differences of the skeleton, in the air-bladder, etc.). These differences, however, in many species are so inconsiderable that we can hardly use them as a basis for distinguishing paleontological species, if we consider that the fossil print incorporates a number of changes and disturbances of the several parts of a body.

In studying the skeleton, the possibilities of biological investigation are by no means exhausted. Even the usual X-ray picture shows that the soft parts of the body appear on the negative in varying degrees of intensity. On fishes, for instance, the air-bladder will appear very clear and sharply outlined, especially if the picture has been taken immediately after the death of the animal. A procedure, so generally adopted in medical practice, to inject certain solutions or emulsions into cavities on account of their relative impermeability to X-rays in order to make them visible on the negative, points a way to a method which has been hardly used at all.

I injected barium sulfate solutions into the heart and the larger vessels of fishes and obtained pictures which are clear to the most minute detail; many show even the last capillary vessels absolutely plain. That in such pictures each vessel will be shown in its true position and relation to the rest of the body goes without saying. Here again the advantage of saving a great amount of time and work is apparent. Biologists are well aware that investigations involving the smaller vessels demand preparations which involve months of painstaking technical work.

I know of a distinguished scientist whose studies of the position and relations of the smaller vessels of the human heart demanded years of his time. An X-ray picture of a properly injected organ might have shortened that time to a few hours. It is possible to make just as easily studies of the vessels of invertebrate animals. As a matter of fact, these promise even more success, because there are no skeletons to disturb the picture. The practice of using certain selective staining methods for representing certain elements of the body—for instance, the nervous system—seems to me to be altogether within the limits of adaptation.

In the same manner as vessels, other cavities can be shown by means of injections. Here is the main field for roentgenographical work in botany. Also the entomologist, who studies plants that have been attacked by insects, will surely find in X-ray pictures a valuable help.

Naturally each field of investigation and its peculiar technic must be studied in all its particulars. The representation of the blood vessels, too, necessitates certain preliminary conditions and a certain practice which can be acquired only through experience.

In a forthcoming paper I am discussing the methods and advantages of X-ray pictures as applied to zoological and botanical materials. The use of this method is fully demonstrated in a monograph on Hawaiian fishes, now in preparation.

VICTOR PIETSCHMANN

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A CONVENIENT METHOD OF DETERMINING THE RATE OF CLEAVAGE

FOR the study of factors influencing the rate of cleavage of developing eggs, it is essential to determine that rate for a large number of eggs. Since the individual differences in the time of cleavage usually extend over a period of only a few minutes, the counting has to be done quickly. The inexperienced worker will have to spend some time in acquiring the necessary skill for obtaining reliable data.

The following convenient and accurate method is suggested. The camera lucida is used. Note the time of the appearance of the first cleavage of the eggs in the microscopical field, and from now on mark on the drawing paper, with the aid of the camera lucida, all those eggs that divide within the first two minutes with No. 1 written across the image of the egg. Eggs dividing within the next two-minute period, mark with No. 2, and so on until the whole field has divided. A record is left on the paper. Now count from this record the number of eggs marked with 1, 2, 3, etc. You thus obtain the data for a regular distribution

curve from which you read off the average time at which cleavage of a large number of eggs occurred.

The advantages of this method are: a permanent record is left on paper; the counting is done with ease after the process has passed; each egg is counted only once, the mark across the image of the egg on the paper indicating the eggs already counted in the preceding period.

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SPECIAL ARTICLES

THE EFFECT OF A SECONDARY SOUND UPON HEARING

THE problem of hearing in the presence of a secondary sound has of late received considerable attention from correspondents of this journal. The ancient belief that certain persons suffering from paracusia, in the form of a partial deafness of the conduction-type, are able to hear more acutely in noisy surroundings than under conditions of quiet has been brought to question and debated on various sides.¹

The matter seems at last to be decided by the excellent experiments of Knudsen and Jones, reported recently.² The threshold of hearing was ascertained for speech-sounds and for a faint tone both in silence and with a constant noise, and it was shown that for all subjects, normals and defectives alike, acuity is reduced in the presence of a noise. This finding is not incompatible, it must be noted, with the well-attested fact that under particular conditions the paracusic can carry on conversation more easily in the presence of a secondary sound. The phenomenon is a consequence not of an increased sensitivity of the acoustic mechanism, but rather of a relative advantage which the situation affords the paracusic over his normal companion.

The explanation is plain. The commonest auditory defects involve a considerably greater reduction of low tones than of high tones, and since most extraneous noises are made up predominantly of low-pitched tones, it follows that the person of impaired hearing is deaf to the secondary sound relatively more than he is to the essential tones of speech (which are of higher pitch) and thus in conversation is disturbed by the sound relatively less than is a person of normal hearing. Now since the loudness of one's voice is adjusted by reference to the background as he hears it, the normal person, being greatly disturbed

by a sound, speaks much louder than usual, but the defective, selectively deaf to the sound, raises his voice but little. The net result of the background, in this situation, is a favoring of the person of impaired hearing, though actually the acuity of both persons is reduced as compared with silence. This explanation is supported by the fact that the illusion of improved hearing in the presence of a noise occurs only in conversation between a normal and a defective, and never between two normals or two defectives.³

All this seems clean-cut enough. The writer has merely to add some remarks upon an experiment which in a measure confirms, and further extends, the findings of Knudsen and Jones and which brings forth an additional problem for settlement. The experiment, conducted at the University of California last year in collaboration with Mr. Stanley R. Truman, was concerned with the effect of a background of tone upon the acuity of the normal ear.⁴ Various frequencies and intensities of tone were used for the background and for the testing-tone, and we found, as Knudsen and Jones did, that at the introduction of a tonal background hearing is always reduced.

However, we came upon the further discovery that the threshold does not remain constant under such conditions. At the entrance of the secondary tone the acuity is considerably diminished, but recovery of sensitivity begins immediately and proceeds at a rapid rate until, under a given set of conditions, it may become three or four times as great as it was at first. Sensitivity does not, however, reach the level shown under conditions of silence; after about two minutes it has attained its highest extent and from then on we found no indication of further significant change.

Just what is the cause of this change in threshold-sensitivity we are thus far unable to state with conviction, but experiments are in progress which it is hoped will afford a clue. It would be interesting as well as significant in this relation to know whether paracusics would show the same type of curve of threshold-recovery as do normal persons under the conditions stated, and whether with prolonged stimulation by a secondary tone the relative advantage which, as has been pointed out, circumstances may afford the paracusic would continue to be maintained. Unfortunately, Knudsen and Jones do not tell us the temporal conditions of their tests, and the presumption is that they took no pains to control them—though it is plain on the basis of our results that the temporal factor is of first importance. It is to be hoped that some investigator with the necessary clinical facilities will extend the work of Knudsen and

¹ See, e.g., 60 (1924), 360; 61 (1925), 260 ff.; 62 (1925), 109-111 and 182; and esp. Kranz, 60 (1924), 549.

² V. O. Knudsen and I. H. Jones, *Laryngoscope*, 36 (1926), 623-663.

³ See Knudsen and Jones, *ibid.*, and cf. H. Fletcher, *Volta Rev.*, 26 (1924), 443 f., 447 f.

⁴ See *J. Exper. Psychol.*, 11, 1928, 98-112.

Jones, and trace the sensitivity of the paracusic ear in the presence of a tonal background throughout its course of change; the result might lead us to a better understanding of this phenomenon not only in paracusia but in normal hearing as well.

E. G. WEVER

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PRINCETON, N. J.

REMARKABLE MUSICAL TECHNIQUE OF THE LARGER ANGULAR-WINGED KATYDID

It is evident that there has been marvelous specialization in the vocal music of the birds, the flute-toned thrushes, including the marvelous hermit, probably leading them all with their tonal embellishments. There has been a parallel specialization among the musical insects of the world. The insects have turned especially to instrumental music, adopting microscopic teeth to be operated upon by a scraping edge as the more common type for their frictional music, in the majority of instances. A mere file-vein and scraper or plectrum to rasp across its teeth seem simple enough as a musical instrument, but even this primitive chitin xylophone offers many possibilities of specialization. It may have teeth of different sizes and spacing, to produce different notes as in the case of certain sound-making ants and beetles, or more than one file-vein may be present on an insect. For the present these specializations of the physical structures of the instrument itself need not be considered. There is a further possibility, and that concerns the technique, the manner of handling the instrument to produce the greatest variety of tones and notes. In the music of man, technique has become the big factor, and marvelous progress has been made in this direction alone by the modern masters over the ancients. In spite of the fact that the crickets have somehow hit upon tonality in their music, and the katydids have not, the latter have nevertheless shown a marvelous specialization in the direction of technique far excelling the crickets. The larger angular-winged katydid has proven himself a master-artist with his xylophone. He has specialized in a manner that makes him a pioneer in his art, at least in our own country. Unfortunately we know too little of the musical behavior of insects elsewhere in the world. This fine katydid, as veritably leaf-adorned as the trees themselves, has somehow learned of the full potentialities of his microscopic file-vein and is making good use of his acquirement. The file-vein is a mere thickened ridge or vein bearing parallel chitin bars or teeth, like the teeth of a comb, these being set practically at right angles to the vein and perpendicular to the surface from which they arise.

An almost universal technique among the crickets and katydids is to draw the scraper entirely across this music-file one or more times to produce a note. In the single chirp of a cricket or the intermittent rasp of many katydids, an extremely rapid back-and-forth movement several times delivered produces the sound. The quaver of the cricket-chirp is due to these alternate wing-strokes. In this manipulation all the teeth of the file-vein are used practically simultaneously. The larger angular-winged katydid has somehow gone far beyond this and has learned to produce a long, slow crepitation of thirty to forty or more clicks, making use of the individual teeth, or perhaps sometimes slipping over two or more teeth. The wing-covers along their upper edge are opened nearly three sixteenths of an inch, and set at an angle that will bring the file-vein of the under side of the upper tegmen against the scraper of the upper side of the under tegmen. The scraper is now slowly moved with nice adjustment and precision over the individual teeth, in a gradual closing movement of the wings to produce the long series of individual clicks characteristic of the more typical "song" of this species.

A count of the teeth of the file-vein, including poorly-developed ones at each end of the file, reveals only from fifty-five to sixty teeth, in a length of about three mm. It is probable that not many more than forty to fifty well-developed teeth are present on this file, which would allow not more than an average of one tooth per click in a series of thirty to forty clicks. This is a remarkable specialization in technique and shows the nice control of the katydid in this behavior. It would appear that no other katydid or cricket in our own country has progressed this far in the matter of technique, and we know as yet too little to speak with any authority covering the technique of any foreign species. This katydid not only makes use of this specialized technique, but it has in addition an intermittent zip, produced by striking all the teeth with one quick draw of the scraper across the teeth.

One wonders how this fine katydid sensed this new technique of tapping the chitin-bars of its dorsal, organic xylophone very slowly, to make each tooth emit a note or tone. The most marvelous thing about life, however, is the way it always seems to sense possibilities in every detail of form and function. Once the chitinous xylophone came into being on its wing-covers, once the scraper began to touch the bars to produce a rasp, potentialities were ahead. In the case of the intermittent rasp or zip of this katydid, one quick closing draw produced the note. Slowing down this closing draw of the scraper upon the file-vein was the next step, and some weird prescience of life has in some manner taught the katydid to do just this.

While the crickets have evolved tone in their musical expressions, the matter of technique such as the katydids have specialized upon, seems quite beyond their moods at present. Yet if any of our crickets could strike pure musical tones upon the individual chitin-bars, as the larger angular-winged katydid is attempting to do with its sounds, their tinkling chimes would mark a new era in the spontaneous expressions of insects. A number of the katydids have evolved complicated little instrumental "songs," involving wide departures in time-relations and variety of phrases, from the simple repetitive rhythms of the more primitive type. All this marks some unconscious specialization, it would seem, toward a fuller self-expression with the potentialities of sound.

It is hard to see just how an uncouth and prehistoric scaled-reptilian type should evolve into a beautiful bird, feathered, songful or finally into an imitable hermit thrush with a soul sensitized for music or pleasurable sounds and whispered tonal harmonies. Yet the lowly insects with their primitive musical instruments, a simple file-vein and scraper, are following the same trend, it would seem. Tonality they have, in the case of the crickets; highly specialized technique and variety they have in the case of the katydids; rhythm and even an ear for synchronous rhythm is evident in both great groups. Is it something unconscious, external and cosmic operating upon life, or is there a subconscious urge, which sooner or later becomes translated into the conscious experience of life? Surely, now are the crickets and katydids conscious of their sound-experiences, but the methods, the genesis of it all constitute a mystery as deep as life itself. The individual seems to have as little to do with it all as the individual cells of our bodies have to do with our own running, our talking, seeing or what-not in body-behavior as a whole. The organic unfolding of the phylum at times seems to be the unit, with the individual functioning as a mere cell in its continuity, but this savors too much of the ultimate meaning of life of which we can have no adequate concept.

H. A. ALLARD

U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

SOCIETIES AND ACADEMIES

THE KENTUCKY ACADEMY OF SCIENCE

THE Kentucky Academy of Science held its fifteenth annual meeting at the University of Kentucky May 12, President Valleau presiding at the general sessions, at one of which Dr. E. C. Stakman, of Minnesota, representative of the American Association for the Advancement of Science to the academy, delivered a very interesting lecture on biologic specialization.

The three divisions, biological sciences, physical sciences and philosophy and psychology, had full programs of papers.

Officers elected were:

G. Davis Buckner, University of Kentucky, *president*.
George D. Smith, Eastern State Normal School, Richmond, *vice-president*.

A. M. Peter, University of Kentucky, *secretary*.
W. S. Anderson, University of Kentucky, *treasurer*.

A. R. Middleton, University of Louisville, *representative*
in the council of the A. A. A. S.

Division of Physical Sciences—W. R. Jillson, *chairman*.
C. S. Crouse, *secretary*.

Division of Biological Sciences—G. D. Buckner, *chairman*; E. N. Fergus, *secretary*.

Division of Philosophy and Psychology—R. M. Beard,
Centre College, Danville, *chairman and secretary*.

A. M. PETER,
Secretary.

THE NORTH DAKOTA ACADEMY OF SCIENCE

THE twentieth annual meeting of the North Dakota Academy of Science was held at the North Dakota Agricultural College on May 4 and 5. Dr. H. L. Walster, dean of the School of Agriculture of the North Dakota Agricultural College, presented the president's address on the theme "The Pursuit of Science in North Dakota." A notable feature of the program was the showing by Mr. Russell Reid, of the North Dakota State Historical Society, of a series of fifty colored lantern slides showing the beauty spots in western North Dakota and illustrating the characteristics and nesting habits of many North Dakota birds.

In his invitation address on "The Biological Value of Practical Agricultural Experimentation," Dr. J. Arthur Harris, head of the department of botany of the University of Minnesota, urged the point of view that much of the material results from agricultural experimentation could, through careful biometrical analysis and similar studies, be made to yield much material of great value in pure science.

The following officers were elected for the ensuing year:

President—Dr. G. A. Talbert, professor of physiology, University of North Dakota.

Vice-president—Dean R. M. Dolve, school of mechanical arts, North Dakota Agricultural College.

Secretary-Treasurer—Dr. G. A. Abbott, professor of chemistry, University of North Dakota.

Additional members of Executive Committee: Professor J. H. Seymour, Valley City State Teachers' College; Professor C. H. McLees, School of Forestry, Bottineau.

Representative of the North Dakota Academy of Science on the council of the American Association for the Advancement of Science—Dr. H. L. Walster, dean, School of Agriculture, North Dakota Agricultural College.

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The Journal of Experimental Zoology
American Journal of Physical Anthropology
The American Anatomical Memoirs
The Biological Bulletin (M. B. L., Woods Hole, Mass.)
Folia Anatomica Japonica (Tokio, Japan)
The Journal of Parasitology (Urbana, Ill.)
The Australian Journal of Experimental Biology and Medical Science (Adelaide, South Australia)
Stain Technology (Geneva, N. Y.)
Physiological Zoology (Chicago, Ill.)

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If vacancies occur, students from other institutions desiring advanced standing may be admitted to the second or third year provided they fulfill the requirements and present exceptional qualifications.

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SCIENCE NEWS

Science Service, Washington, D. C.

THE COLD LIGHT OF SEA ANIMALS

MAN will face new and important ways of controlling nature when he succeeds in demonstrating the mechanism by which tiny organisms of the sea produce light without appreciable heat, Dr. Charles A. Kofoed, of the University of California, said in his presidential address before the Pacific division of the American Association for the Advancement of Science at Claremont, Calif., on June 13.

Dr. Kofoed described the occasional outbreaks of luminescence in the ocean by night, when each breaking wave is accompanied by an outburst of flaming light, and the path of a vessel becomes an illuminated trail across the water. By day, the water of the luminous sea is rusty red, and mottled with patches of color. The luminous outbreak brings death and destruction to tons of sea creatures, and has baffled attempts of scientists to plumb the mystery to its exact source.

The epidemics of light have been definitely traced to tiny sea animals with the long name of dinoflagellata, which sometimes develop and multiply with what seems like an astonishing ambition to cover the ocean. But what causes such enormous flares of growth is still to be explained.

The fact that the outbreaks occur so frequently off the Pacific coast of this country rather than off the Atlantic is a clue that local conditions of weather and sea geography may play their part in the mob drama of the dinoflagellata. Chemical analysis of sea-water patiently made over long periods of time is also expected to reveal some evidence of the exact kind of water in which the creatures flourish. It is also possible that the organisms themselves produce some substance which favors their own growth, and that they flourish and multiply until the food supply becomes inadequate and then the surplus hordes starve.

The task of handling and experimenting with these delicate organisms is extraordinarily difficult, Dr. Kofoed said, because they are attuned to an environment of great constancy, and the changes in their environment which cause them to respond are slight compared with other creatures of the animal world.

"The secret of the production of light without appreciable heat is locked up in the metabolism of these simple organisms of the sea," Dr. Kofoed said in conclusion, pointing out that some of the most inviting problems of biology are involved in understanding the relations of these organisms to the solar radiations on which they depend and in demonstrating the mechanism by which they release their stored-up reserves of energy.

CHEMICAL BONDS AND LIGHT WAVES

THE chemical bonds between particular kinds of atoms are tuned precisely with certain wave-lengths of light, according to recent discoveries of Dr. Joseph W. Ellis, physicist in the University of California. Instead of co-

operating with the light radiation, however, these chemical attachments nullify or absorb the special light waves to which they are attuned. Dr. Ellis thus identifies the bonds by noting the kind of light which does not get through the substance he is investigating.

For decades chemists have been able to tell what elements are present in a substance, and in most cases how many atoms of each. The pattern by which the atoms are tied together in compounds, however, is known or guessed only on circumstantial evidence. Nevertheless the pattern is all-important. Dr. Ellis' experiments show which atoms are directly bonded together.

Chemists would gladly accomplish all this by magnification and direct photography of the molecular structure. Unfortunately this is impossible with atoms only one two hundred millionth of an inch in diameter, and light waves five thousand times as wide.

By the new methods infra-red, or low frequency, rays are passed through simple chemical compounds like aniline, alcohol, etc., whose structure is already known and undisputed. Accurate measurement is made at the odd places in the spectrum where a stoppage of light is caused by particular chemical bonds. Dr. Ellis is able to specify with high numerical accuracy just what wave-length, or color of light will be absorbed if a substance under examination contains, for example, a nitrogen atom attached to a hydrogen atom. Nitrogen and hydrogen atoms scattered about in other relations and tied to other atoms give no such response. Similar data have been obtained for the carbon-hydrogen and sulfur-hydrogen bonds. Many additions to the list are expected with further research.

By combining a spectrograph and camera with electrical accessories, the physicist simply tests his substance down the gamut of the spectrum from blue to infra-red. Each chemical bond automatically records its presence by a dent in the photographic line record. Just as a piano wire may respond to sounds in more than one octave, so the chemical bonds give over-tone records which confirm the proof desired.

Even greater value may lie in the possibility of calculating the strength of a chemical bond. Dr. Ellis is enabled through mathematical physics to show how firmly a substance is bonded on a basis of the wave-length chosen. From such a computation it may be possible to predict in some degree the possibility of some desirable chemical reaction taking place.

EMISSION OF RAYS BY PLANT CELLS

THE latest sensation in scientific circles in Berlin is the discovery that the apex of certain rapidly growing vegetable and animal tissues emit some sort of invisible radiation which has the power to stimulate the growth of living matter with which it is not in contact. When this was first announced in 1924 by Professor Alexander Gurwitsch, of Moscow, it was received with considerable

NEW SCIENTIFIC BOOKS

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TEXT-BOOK OF ORGANIC CHEMISTRY. Joseph S. Chamberlain. pp. xxx+901. \$4.00. Second edition.

An expression of the author's teaching experience, the book is written primarily as a text-book for the undergraduate student and instructor, but it is hoped that those who have already studied the subject may find it of value for its general presentation.

The Williams and Wilkins Company, Baltimore

SIR ISAAC NEWTON. Edited by F. E. Brash. pp. ix+351. \$5.00.

A series of essays giving a modern interpretation of the great English physicist through American eyes. Discusses Newton as a physicist, mathematician, chemist, astronomer, philosopher, etc.

The McGraw-Hill Book Company, New York

ELEMENTARY ORGANIC CHEMISTRY. Homer Adkins and S. M. McElvain. pp. xi+183. \$2.25.

A summary of facts such as students might be expected to note down, leaving to the individual instructor the vitalization of the subject. Intended for a one-semester course in colleges, normal schools and summer schools.

The Cambridge University Press,

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WILLIAM BATESON, NATURALIST. pp. ix+473. \$8.40.

A collection of his essays and addresses together with a short account of his life by Beatrice Bateson.

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AN OUTLINE OF PHYSICS. Albert E. Caswell. pp. xiv+773. \$4.25.

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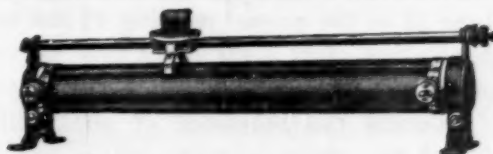
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skepticism here, but now it has been confirmed by German investigators who are eagerly prospecting the new field of research in various directions.

Gurwitch found that if the tip of one of the rootlets of an onion or turnip was fixed so as to point at right angles to the side of another root, though as much as a quarter of an inch away, the cells in the side nearest the tip would multiply more rapidly than elsewhere and so bend the root away. That this influence was not due to the emission of some gaseous emanation from the root tip was proved by the interposition of a thin sheet between the two roots. Glass and gelatin sheets stopped the transmission of the growth stimulation power but quartz did not. This is characteristic of ultra-violet rays and Gurwitch concludes that the radiation from the root tips has a wave-length of 180–200 millimicrons, which would place it among the ultra-violet rays of high frequency.

The German botanist, N. Wagner, has repeated these experiments with bean and onion roots and measured the effect by counting under a microscope the number of new cells produced in the roots acted upon. The increase is as high as 70 per cent. in some cases. Old cells that have ceased growing show the greatest relative increase.

The German bacteriologist, M. A. Baron, has found that the radiation from onion roots will likewise accelerate the growth of anthrax bacillus and other bacteria. The growing tip of toadstools gives off these same growth-generating (mitogenetic) rays.

The Siemens Electrical Company has taken up the question and Doctors Hauser and Vahle working in these laboratories report that certain growing animal tissue, such as cancer, emit such rays.

These results, if confirmed, will radically revolutionize present theories of life and growth. It has hitherto been assumed that the impulse to cell subdivision was somehow due to the direct contact of certain chemical substances transmitted through the tissues, but it now seems that an energy agency is active in vital processes, an immaterial radiation of the nature of light but of too high a frequency to be detected by our eyes.

PUBLIC HEALTH AND THE PHYSICIAN

CARE of the public health is the particular province and special responsibility of the physician, said Dr. William Sidney Thayer, of Baltimore, new president of the American Medical Association, in his inaugural address on June 13 at the annual meeting of the association in Minneapolis.

"In the first place we should use every means in our power to maintain the character of our public health officials," said Dr. Thayer. "Conditions have changed for the better but we are still treated too often to the humiliating spectacle of a mayor who appoints his family physician or some friend who has tired of practice to the position of commissioner of health."

Speaking to the 6,000 physicians who have assembled here, representing the organized medical profession of the country, Dr. Thayer reminded them of the object of their association as stated in its constitution: "... to

promote the science and art of medicine and the betterment of public health." It is this altruistic attitude that marks the difference between medicine or any other profession and trade which has financial gain as its primary object. The true physician will not forget this difference and while he must earn a living, "if his main interest be not in his profession or if financial gain be his sole object, he will accomplish little and his name will be soon forgotten."

Of a physician's functions, the first, and most obvious, according to Dr. Thayer, is the individual care of his patients, after which comes prevention of epidemics, which requires attention to every detail involved in the spread of disease including cooperation with local boards of health by reporting communicable diseases, enforcing quarantine regulations, etc.

"Too early specialization is one of the great faults of modern American education," declared Dr. Thayer, speaking of the future of medical education. "The medical school is not the place for the training of specialists . . . the specialist who has not had a good basic medical training is a danger to society." Dr. Thayer also voiced the feeling current in many medical schools to-day that too much is being crowded into the four years' course. In this connection Dr. Thayer expressed the hope that "such elementary methods as a prescribed four years' course" will disappear from our medical education, schools of medicine in the future will be organized so that the student will be treated as a man and not as a schoolboy.

SENSITIVITY TO SUNBURN

WHETHER or not you sunburn easily may now be tested in a doctor's office, without going to the seashore. At the meeting of the American Physical Society in Claremont, Calif., on June 15, Dr. Robert C. Burt, of Pasadena, told of a new instrument that he has invented and calls the "erythemameter." It measures sensitivity of a person to erythema, as the physician terms painful sunburn.

Erythema, or sunburn, is caused by the ultra-violet rays in the sun's light. It can also be caused by ultra-violet light from a quartz tube mercury vapor lamp, or one of the other forms of lamp now being used in the treatment of rickets and other diseases. In Dr. Burt's instrument such a quartz lamp is contained in a light-tight box from which the ultra-violet rays can escape through a hole about two inches square. This opening is placed directly against the bare skin of the person being tested.

A set of filters in back of this hole cuts off more and more of the rays so that the skin at one edge gets the full benefit of the rays from the lamp, while that at the opposite edge receives none. After being exposed to this apparatus for ten minutes, the untanned skin of any one becomes burned at the side receiving the most rays. The distance that the burned area spreads measures the person's sensitivity.

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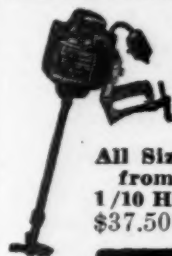
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the opening also. This moves across the hole in a direction at right angles to that at which the intensity varies. When the exposure is complete it has moved completely across. The result is an actual curve drawn on the subject's skin which shows how long an exposure he can stand to ultra-violet rays of any intensity.

The instrument is expected to be useful to physicians who are now using ultra-violet rays in the treatment of disease. Over-exposure of a sensitive person to them may be very harmful, and by making a test with such an instrument, serious effects can be prevented.

Dr. Burt also described another instrument of his invention that measures intensity of ultra-violet light, either from the sun or an artificial source. It makes use of a photoelectric cell, in which light is converted to electricity, but a cell made of quartz, instead of glass, which is opaque to the rays.

"The instrument is so portable and easy to use," says Dr. Burt, "that the day may come when up-to-date bathing beaches will have an observatory giving out the intensity of the sunburn light in the sun, so that each person may stay out just long enough to become a delicate brown, without becoming severely burned."

TREE GROWTH AND THE WEATHER

A NEW theory regarding the period of greatest growth of California's big trees, or *Sequoia gigantea*, has recently been advanced by Walter Fry, commissioner for Sequoia National Park and for 40 years a student of natural conditions in the big tree park area.

Most scientific men have for years held the theory that the greatest growth of the trees was made in wet years or the years of the most snow. Judge Fry disagrees with this, contending that the Sequoia makes its greatest growth during dry seasons, and its least growth when the ground is covered with snow until late in June. Superintendent White, of Sequoia National Park, agrees with this latter theory.

The growing season of the Sequoia, occurring at elevations varying from 5,000 to 8,000 feet, is necessarily short. The judge points out that the big trees do not begin to bud until the snow has disappeared and the sun begins to warm the ground. In years when the snow remains late on the ground the growth of the trees is retarded, while in winters of light snowfall the ground is free of snow early and the trees have a longer growing season and the rings therefore have a greater growth in the dry years.

Judge Fry, to prove this contention, has counted the annual rings on a large number of down trees. The largest of all that he has counted, a fallen monarch of the Converse Basin near the park, has 3,226 annual rings. According to the judge a study of this tree shows that it had its fastest growth in the years between 400 and 250 B. C., and its smallest growth in the years between 650 and 800 A. D.

His years of investigation and study among the big trees lead the judge to believe that the climate of that portion of California in which they thrive has remained practically the same throughout the life of the Sequoias,

although 1923-24 appear to have been the dryest years known to man.

ITEMS

FOUR Antarctic sea elephants, among the rarest of all large animals, have been brought to Hamburg by the great animal-importing firm of Carl Hagenbeck Company. At the present time no European zoo can boast the possession of a specimen. Other importations from the Antarctic include 25 king penguins and 35 gold-crested penguins. South America has contributed two very rare animals, the maned dog and Magellan's wolf, in addition to better-known creatures such as tapirs, ant-bears and jaguars. From Africa a new subspecies of chaema, a kind of baboon, has been brought for the first time.

A PROCESS for getting oil out of steam condensation water has been developed by Fritz Hoyer, a German scientist. It is expected to replace the mechanical methods for removing the troublesome residue of oil now in use. Most of the oil which is used for lubricating steam pistons and gearing is atomized and carried away in the waste steam. As a result of this a very stable milky emulsion is formed on the condensed water, and the problem of separation of oil and water is an extremely difficult one. In the Hoyer process a direct current is passed through the water, which collects the oil in small foam flakes, thus destroying the emulsion and making filtration possible. The consumption of electricity is about one kilowatt hour for five cubic meters of water.

THE relationship between lack of sufficient food and tuberculosis has been definitely proved by Dr. Harry Schutze and Dr. S. S. Zilva, of the Lister Institute. In their experiments with tuberculosis in guinea-pigs during the last six years they have found that diet is a very important factor. They divided their animals into two sets; one set was given a complete normal diet, with abundance of food, and the other set had a similar diet but restricted in amount. The guinea-pigs on the restricted diet did not put on weight, whereas the others did. After two and one half months of dieting, all the animals were inoculated with a living culture of tubercle bacilli, in order to test their resistance. In each case the animals on the abundant diet lived twice as long as those on the restricted diet.

WHILE to-day walrus are practically confined to the little-visited Arctic seas, within historic times they have been common as far south as the Gulf of St. Lawrence, and the recent finding of a skull on Georges Bank, off the coast of Massachusetts, seems to indicate that these mammals did come down as far south as northern United States waters perhaps no longer than two or three hundred years ago. This interesting specimen, consisting of the fore part of a walrus skull with the tusks still in place, was recently dredged up by the steam trawler *Mariner* at a depth of eighty fathoms. Colonel J. M. Andrews has turned the skull over to the Boston Society of Natural History.